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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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The B.C.I.R.A. Scottish Laboratories are:—

Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332*).

Forthcoming Events.

NOVEMBER 12.

Institution of Welding Engineers (Birmingham Branch):—Ordinary meeting. "Eye Protection during Welding Operations," Paper by R. R. Butler, M.Sc., F.I.C.

NOVEMBER 15.

Sheffield Metallurgical Association:—Ordinary meeting. "Controlled Furnace Atmosphere," Paper by Eric W. Fell, Dr.Eng., M.Sc.

NOVEMBER 16.

Institution of Welding Engineers:—Ordinary meeting in London. "Cutting Steel with Oxygen Machines," Paper by C. G. Bainbridge.

Institute of British Foundrymen.

NOVEMBER 12.

Scottish Branch (Falkirk Section):—Ordinary meeting. "Heat-Resisting Cast Iron," Paper by J. W. Donaldson, D.Sc.

Wales and Monmouth Branch:—Ordinary meeting at Bristol. "Some Methods of Production in a Modern Malleable Iron Foundry," Paper by H. J. Beck.

West Riding of Yorkshire Branch:—Ordinary meeting. Discussion on "Iron Castings *versus* Fabricated Parts," Paper by A. W. Walker and E. B. Shore.

NOVEMBER 18.

Sheffield and District Branch:—Ordinary meeting. "Mammoth Castings for the Cunarder building on the Clyde," Paper by F. Swift.

The Extended Duties.

The extension recently announced by the Import Duties Advisory Committee of the three months' period of protection originally accorded to the iron and steel industry by a period of two years has naturally been welcomed by the industry. It was obvious from the beginning that a period of three months was inadequate to justify any radical change of policy on the part of the British plants, and, indeed, was only imposed to give time to determine first of all what period should be specified, and secondly where duties originally imposed should be modified. The two-year period will undoubtedly furnish the necessary incentive to take the fullest advantage of the duties, although the Committee has not seen fit to alter the duties themselves, in spite of the fact that material is still coming in below the British cost of production. For reasons which are well understood these prices do not represent an economic cost of production. The continuance of the duties has been made conditional upon the reorganisation of the industry, and negotiations to this end are proceeding.

The effect of the changes in conditions are well illustrated by recent import and export figures for iron and steel castings. For example, during the first nine months of 1931 we imported iron and steel castings to the extent of 16,000 tons approximately. During the first nine months of 1932 this figure had fallen to just over 4,000 tons. The values in the two cases were respectively £260,000 and £84,000. While the drop is undoubtedly due in part to the depression there is no doubt whatever that the duties have played a part.

Turning to the other side of the picture and dealing with exports, for the first nine months of 1931 we exported about 70,000 tons of castings having a value of approximately £1,233,000, and for the first nine months of 1932 our exports were about 62,000 tons, having a value of £1,011,000. This slight fall in the export figure is also due in part to the depression. Free traders will, of course, argue that the restriction of imports is bound to affect our exports, and, to some extent, this is perfectly correct. At the same time there is reason to believe that exports from other countries have fallen much more markedly than our own, and our position has been summarised by the Prime Minister as very little worse in 1932 than in 1931. There are in some quarters definite signs of improvement, and the striking success of the motor show may be taken as one illustration of reviving confidence.

Stocks—Zero.

Many sections of the foundry industry, such as steel, jobbing, heavy non-ferrous, are not subjected to the ordinary laws of supply and demand, because a *lower price does not affect the demand*. Each job is put forward by the buyer with a knowledge that no stocks exist, and, unlike the commodity market, where there is always a physical supply, and generally a surplus, diminishing demand involves an increase in stock. This usually has to be realised in the form of hard cash, which further depresses the market price. For a large section of the foundry industry there is no reason why the price should not be based upon cost of production plus profit. The case of steel castings is particularly glaring, because the number of foundries involved is relatively small, and a "get together" with this elementary principle uppermost in the minds of its constituent members, the price of steel castings could be raised to a profitable basis within a month. All that has to be done is to revise every price quoted on the basis of *actual* costs of production plus a fair margin of profit. What is happening at the present time is as plain as daylight. The amount of business to be placed is a mathematical constant "K." It usually goes to, say, the Edgar Hadfield Company because of geographical considerations, friendship, previous business connection, quality, service and price. It is taken by the Lloyd & Elliott Company on price alone. Then Lloyd & Elliott's lose some of their business to Edgar Hadfield's on similar grounds. There is exactly the same quantity of business placed as before, but both orders have gone at lower prices. Surely it should be obvious that as *demand* can be ruled out of all consideration, *conditions of supply* are in the hands of the foundries.

District Presidents.—No. 10.

CHAIRMAN OF THE YORKSHIRE SECTION OF THE BRITISH WORKS MANAGEMENT ASSOCIATION.

Mr. H. F. Coggon was born in Grimsby, and educated at the Wesleyan Higher Day School at Grimsby, Wintringham College and Sheffield University. He was actively engaged in the early development work in low-temperature carbonisation in the South Yorkshire coalfields in association with the late T. Scott Anderson, M.I.C.E., and Drs. Melterich and Müller.

During the war he served with the Sheffield City Battalion in Egypt and in France in the Somme offensive. Invalided from the Army in March, 1918, he was engaged in Admiralty contract work and later joined the staff of Cammell-Laird Company, Limited. Effects of war

Mr. H. F. Coggon

(Chairman of the Yorkshire Section of the British Works Management Association).

injuries caused a breakdown, and after a long convalescence he commenced business on his own account. In association with the late Dr. Arnold and Messrs. Wild and Barfield he arranged an exhibition at Sheffield University of electric furnaces, and later became associated with August's Muffle Furnaces, Limited. On the rearrangement of the management of that company he became a director, and later was appointed managing director. He is also managing director of Lead Pipes, Limited, and Automobiles (Geographical), Limited.

Mr. Coggon is a member of the London Branch of the Institute of British Foundrymen, besides being chairman of the Yorkshire Section of the British Works Management Association and chairman of the Foremen's Mutual Benefit Society (Engineering, Shipbuilding and Allied Trades), Halifax District.

Boonville Bridge, U.S.A.—The new bridge carrying the Missouri-Kansas-Texas Railway over the Missouri River at Boonville, Mo, includes a vertical-lift span 408 ft. long and weighing 1,200 tons. It is claimed for this that it is the longest span of such description yet built. The superstructure of the bridge, which is 1,638 ft. long and weighs about 3,700 tons, is stated to be remarkable for its extensive use of high-strength silicon steel.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

"Is 'Foundryman' an Americanism?"

To the Editor of The Foundry Trade Journal.

Sir,—According to the searches which your current Leader on the above subject recites, the term "foundryman" is not a dictionary word. Had it been, one would have expected to read a definition such as: A man whose occupation is in a foundry.

The expression may be used for a mechanic, or a labourer or an electrician as correctly as for a moulder if their work is within a foundry. It would not, with word-correctness, be applicable to a metallurgist whose work was outside a foundry, no matter how essential his work were to the foundry.

Informal terms become formal by constant and unchallenged repetition, and it is advisable (if we value accuracy in speech at all) to examine the term "foundryman" critically before accepting it as representing the desired meaning. If it is desired to describe all and sundry occupied in producing castings or accessorily in a foundry, it appears appropriate. If only those practising the art of founding are intended, there is the better and dictionary word "founders." There does not appear to be a term defining together those practising the art of founding and those scientifically studying founding.—Yours, etc.,

Victor Stobie
(President, Institute of British Foundrymen).

South Drive, Harrogate.
November 7, 1932.

British Standard Specification for Manhole Openings.

A new B.S. Specification for manhole openings for chemical plant has just been published by the British Standards Institution. The question of the protection against accidents when cleaning out process vessels, mobile tanks and storage tanks has been one which has occupied the minds of chemical engineers for some time. It was felt that the need for standardisation was long overdue and that a lead in this direction would be specially welcomed by the chemical industry and, in particular, by the chemical-plant manufacturers.

During the preparation of this Specification a wide range of processes was examined, with a view to introducing standards for general application. The evidence collected pointed to the need for fixing the minimum number and sizes of openings in vessels and tanks to allow adequate ventilation during emptying, cleaning, repair, and to give a reasonable chance for effective rescue work in cases of accidents. To meet the varying conditions of service, vessels are classified as Process, Mobile or Storage tanks.

There has been no attempt to lay down a standard design—this is left to the individuality of the manufacturer. The Specification is therefore stated, in general terms, to give latitude in detail design for pressure or vacuum work and for special cases. The Technical Committee responsible for the drafting of the Specification was constituted as follows:—

Mr. J. C. Kellam (Chairman), Major A. T. Sumner (War Office), Mr. L. C. McNair (Home Office), Mr. C. F. Howard (Association of British Chemical Manufacturers), Mr. J. R. Tyrell (Association of British Chemical Manufacturers), Mr. J. Davidson Pratt (Association of British Chemical Manufacturers), Mr. H. W. James (Association of Tar Distillers), Mr. B. F. Pinnegar (British Chemical Plant Manufacturers' Association), Mr. J. Thompson (British Chemical Plant Manufacturers' Association), Mr. C. H. Davy (Coke Oven Managers' Association), Dr. R. Seligman (Institute of Brewing), Mr. C. Dalley (Institution of Petroleum Technology), Mr. C. Humphrey Davy (Messrs. Babcock & Wilcox, Limited), Mr. A. Alliott (Society of Chemical Industry and Institution of Chemistry), Mr. D. A. Brown (Finnieston Engineering Company, Limited), Mr. C. D. Pollard (Messrs. T. Firth & Sons, Limited), Mr. T. H. Burnham (Messrs. Hadfields, Limited), Mr. M. McNeil (Messrs. Charles McNeil, Limited), Mr. A. E. Thompson (Messrs. Thompson Bros. (Wolverhampton), Limited), Mr. R. H. Gummer (Messrs. the Combustion Steam Generator, Limited), Mr. V. B. Harley Mason (Manchester Steam Users' Association), Mr. F. Petheram (Engineering Insurance Companies), Mr. E. F. Price (Railway Companies of Great Britain and Ireland), Mr. L. Rose (Institution of Automobile Engineers).

(Concluded from previous column.)

Copies of this Specification (No. 470—1932) may be obtained from the Publications Department, British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2s. 2d. post free.

A New Appointment.

Mr. A. S. Beech has been appointed managing director of Messrs. Foundry Equipment, Limited, of 15, Victoria Street, London, S.W.1. Mr. Beech is one of the most prominent personalities in the foundry industry. After serving an apprenticeship with Messrs. Richard Johnson, Clapham & Morris, Limited, of Newton Heath, Manchester, he left them to join H.M. Forces in 1914, and was invalided out in 1915. He was then appointed assistant foundry manager at the Westland Foundry of Petters, Limited, at Yeovil, Somersetshire. In 1919 he was appointed director of the Universal System of Machine Moulding & Machinery, Limited. He was a founder of the Foundry Trades Equipment and Supply Association, and was President of that body two years ago. He has lectured before several of the Branches of

Mr. A. S. Beech.

the Institute of British Foundrymen, and is now a Vice-President of the London Section. His new firm, Messrs. Foundry Equipment, Limited, will manufacture the well-known Baillot foundry plant in England.

Why Educate the Foundryman?

A SCHOLASTIC VIEW.

An address entitled "Why Educate the Foundryman?" was delivered to the members of the Lancashire Branch of the Institute of British Foundrymen, at the Openshaw (Manchester) Junior Technical School, on October 1, by the Principal of the School, Mr. S. P. Howden, M.Sc. The chair was taken by Mr. Ellis Flower, the Branch-President.

The Chairman said Mr. Howden was one of the few academic men who realised that the work in the foundry, besides being arduous, required the highest skill. Since the school was opened he had laboured strenuously for the benefit of the rising generation of foundrymen. By all kinds of methods, he impressed the educational authorities with his belief that classes alone were not sufficient to train the foundryman of the future. During the past year arrangements had been made which would enable the juniors to sit for the certificate of the City and Guilds of London Institute.

Mr. Howden said for many years he had admired the work of the foundryman. The late Mr. Oliver Stubbs interested him in the subject, and he owed more to that gentleman than to anyone else for erudite guidance. In 20 years' experience as Principal of the school he had met many types of leaders in industry and foremen, and there were two who stood out vividly in his recollection, who were represented to him to be uneducated. One of them was a foreman in the iron foundry of one of the largest local firms, who showed him by practical demonstration that there was elasticity in cast iron. He also propounded some problems to be thought over. Taking him (Mr. Howden) to a casting, he said, "I have made hundreds of that. If I cast it one way up, I put 1 ton on it to keep it down; if I cast it the other way up, I have to put 5 tons on it to keep it down. Why is it?"

He puzzled very hard over that problem. He spent hundreds of hours in the Openshaw Library and did scores of experiments before he discovered the answer to that question. Then it flashed across his mind. That foreman had rediscovered what was now known as Pascal's law of liquid pressure.

In that way a solution of the problem was arrived at by a man who might be termed uneducated. He himself (Mr. Howden) had never tackled the problem before—never heard of it—but he had learned the law of liquid pressure, and after a time it came into his mind. It took that foreman hundreds of hours to arrive at the solution; a man who had a scientific education would not take much more than an hour. That was an example of the advantages of scientific education. It gave a short cut to an explanation of difficulties, and inspired greater confidence in dealing with them.

In another department of Armstrong, Whitworth & Company, a man had to remove some very heavy castings. He managed it with a few yards of rope, a few billets of wood, a chain, a few men. A college-trained youth, one of his (Mr. Howden's) pupils, was looking on, and asked, "Do you know mechanics?" "No." "How do you know what you should do?" The man replied, "It's 'savvy.'" Foundrymen should have that "savvy"—an abundance of it—but education was needed to give them confidence; and they would still have "savvy."

Practically every advance in the chemical industry had been made by Englishmen. But a German student said to him some time ago that in Germany there were hundreds of well-educated youths ready to follow up and take advantage of the work of the man of genius. That was an instance of the advantages of education. The foundryman should be educated so that he might be able to take up what other people discovered, to emulate them.

Never had there been a time when the trade was so menaced as it was to-day by the extension of welding. A manager told him that five years ago they had 35 patternmakers and two welders in his shop; to-day there were 78 welders and two or three patternmakers. He had been told by influential men that if he did not start welding classes in the school, he would retrogress. He could not develop enthusiasm for welded materials. He believed foundrymen could meet that menace if they were allowed to develop. But it meant more education.

He did not wish to be pessimistic. Mr. Flower in his presidential address referred to the advance in motor-car construction. Good work in the foundry was the foundation of all the progress which had been made in the manufacture of motor cars, as in other branches of the engineering industries. The enlightened knowledge of the foundryman, derived from education, would be an important factor in enabling engineers to cheapen production and meet the competition from abroad.

The third reason why he urged that the foundryman should be educated was that it would make the foundry industry more attractive and bring into it youths of the best class. Some people said it was the mothers who objected that it was a dirty job. He questioned that. No doubt some foundries were allowed to be in a dirty condition, but there were others it was a pleasure to visit. Sectionalism was a real danger. Industry suffered from the dead hand of the medieval craft guild which stipulated that the cobbler might patch but must not make, that a saddler might attend to the leather but he must not touch the metal, that a boy should be a core maker, a bench moulder, a plate moulder, a floor moulder, or a cupola man, or an iron dresser. Restrictions of that kind were not fair to the boys. Give them the chance to gain wide experience, an all-round shop training, which would keep them busy until they left. That was what the boys themselves wanted as they were seeking experience. If it could not be done in the foundry, do the next best thing. Let them have a wide education in the school and secure the national certificate for foundrymen.

Teaching was a very difficult art, and it was not easy to secure a man who, besides being trained as a teacher, understood foundry work. That qualification was possessed by the Branch-President and by the secretary, and the school now was starting under the best conditions, being helped by the backing of many employers in the neighbourhood, notably their Past-President, Mr. Roy Stubbs. With that they ought to be able to accomplish something. They should be able to educate the young and make the foundry a little more attractive for the best class of youths. In these times it was more difficult to study than ever before. Dance halls, picture houses, billiard saloons drew young men away from education. That tendency must be counteracted, and in Openshaw at least a fine start had been made by providing a school. Students must go through a three-years' course before they sat for the finals. He appealed to foundrymen in general to help in every possible way.

Vote of Thanks.

Mr. T. Makemson, in proposing a vote of thanks, said Mr. Howden's remarks were appreciated by all present. They knew that he regarded the foundry industry and the troubles of foundrymen with deep sympathy, and he had a keen insight into the difficulties which they encountered. During the last year or two he (Mr. Makemson) had met several principals of technical colleges, mainly in connection with the City and Guilds examination, and no one had made better progress with the job than Mr. Howden. The classes were organised on the best lines. He had tackled the job both thoroughly and systematically, and if the classes were a success anywhere they would certainly be a success in Openshaw.

Mr. Phillips seconded the vote of thanks and it was carried unanimously.

Mr. Shackleton Bailey, M.P., said he was very glad he had come, because he had listened to an address which was provocative of thought and reached the heart of the problem. In his presidential address, Mr. Flower raised a point which concerned every industry. His own view was that those engaged in industry on the productive side must see to it that they got a proper return for what they did. How could they do so with merchants wanting to charge the consumer highly and whilst paying the producers (amongst them the foundrymen) as little as possible? The only way to combat the evil was to organise the industry with the object of getting a reasonable return for productive work—at any rate to see that the price paid by the consumer for the finished article is not totally out of proportion to the price paid to the producer. The necessary organisation could only be done by educated men in the industry working for those ends. That was how the position impressed an outsider like himself.

Boys who had intellectual gifts which enabled them to stand out from the rest as the best one in a hundred or the best five in a hundred, benefited by the existing educational system with its emphasis upon what might be called the literary type of education. The school would provide another type of education, more valuable in the circumstances and more suited for the people it was designed for. It would qualify the boy for the life he was to lead and for the work he was to do. Men were needed who had learned a practical trade. This school was intended to give technical education of that sort, and he hoped that would be done to a greater extent than at present in all the great industrial centres.

Mr. Roy Stubbs said he was convinced that in a few years there would be better openings for boys in the foundry trade, and there was no reason for withholding boys from coming into it. Mr. Howden had a magnificent staff and a splendidly-equipped school. He might have a special night and invite the parents of the boys in the foundry class to attend and see what the boys were doing. That should have a very good effect. In order to get the best out of a boy he should feel that his parents were behind him.

Mr. Howden mentioned sectionalism in the foundry. In their own foundry they had overcome that difficulty, he believed, by starting a little school which had been very successful—indeed beyond their hopes. But there was this point. When the boy attained 18 or 19 he went to some other concern where others got the benefit of the training which had been given to him.

Mr. J. S. G. Primrose said Mr. Howden had this advantage over many of the old teachers, that he caught his students young; the average age of his class was something of the order of 15 years. Looking at the calendar for 1903 he observed that 60 students entered the first foundry class held there, and the average age of the 60 was 37. These were men who had not had the chance that Mr. Howden was giving to the youths of to-day. They acquired their knowlelge by the long, painful process of experience. Now practice could be remodelled upon the lines laid down authoritatively, and better work done and material of a higher grade produced. Facilities had been provided for obtaining the certificates, and they had now an opportunity to get the employers to help by insisting that the men they engaged must have the certificate.

A vote of thanks to the Educational Authorities was moved by Mr. J. Jackson, seconded by Mr. N. Cooke, and carried unanimously.

Heat-Resisting Metals and their Use in the Ceramic Industry.

By J. Ferdinand Kayser (Chief Metallurgist of Darwins, Limited).

(*Concluded from page 265.*)

Heat-Resisting Cast Irons.

During recent years endeavours have been made to produce a heat-resisting metal with a cast-iron base, and a certain amount of success has been achieved in several different ways. The cheapest method is to add silicon. A superior product is produced by adding nickel and/or chromium. Part of the nickel may also be replaced by copper. Table V gives the analysis, scaling temperature, Brinell hardness, and tensile properties at room temperatures of a number of typical heat-resisting cast irons. The corresponding properties of a high-chromium alloy are shown for comparison purposes.

Cast irons containing silicon are exceedingly brittle and are not suitable for use at temperatures over 700 deg. C., as they have no appreciable strength in tension. The use of a cast iron containing more than 12 per cent. nickel can never be economically justified, as an iron-chromium alloy containing approximately 28 per cent. of chromium is much cheaper and at the same time in every way superior. Fig. 5 shows a special cast-iron box containing 16.4 per cent. Ni, 7.7 per cent. Cu and 21 per cent. Cr, and a similar box made from a 28 per cent. chromium-iron alloy after approximately six months in a sulphurous atmosphere at 750 deg. C. The chromium box was unaffected, whilst the special cast-iron box was seriously attacked.

At temperatures below 700 deg. C. there is probably a considerable future for cast iron containing small percentages of nickel and chromium, but the suggestion that any heat-resisting cast iron ranks with nickel-chromium alloys for heat-resisting properties[11] cannot be substantiated.

It is impossible to answer the question "Which heat-resisting alloy is the best?" An alloy which is most suitable for one purpose may be quite unsuited for another. In general the author does not consider that it is advisable that the user should specify the composition of the heat-resisting alloy he requires, but should merely indicate approximately the nickel and chromium contents and place the responsibility for supplying a suitable metal upon the producer. Slight variations of composition which are without appreciable effect upon test-pieces may often have a profound effect upon the soundness of castings and the forgability of metals which are required for forgings, and the producer naturally chooses a composition which enables him to produce the soundest possible castings and forgings with the best possible heat-resisting characteristics.

[11] Robiette, Discussion on "Growth and Scaling of Cast Iron," by Norbury and Morgan, J. Iron and Steel Inst., Vol. 123, 413, 1931.

Vitreous Enamelling.

The vitreous-enamelling industry was one of the first branches of the ceramic industry to utilise heat-resisting alloys, and it now absorbs a considerable tonnage in the form of pettets and furnace parts. For most work pettets must resist scaling in an oxidising atmosphere at temperatures up to approximately 1,000 deg. C. They must have sufficient strength to support the load without distortion and at the same time must not be heavy enough to retard the rate of heating of parts of the ware under treatment. In general the conditions can only be satisfactorily met by a metal containing not less than 60 per cent. nickel and 20 per cent. chromium. Those containing, say, 18 per cent. chromium and 8 per cent. nickel are definitely not satisfactory. They lack the necessary strength at high temperatures and their scaling temperature is not sufficiently high. Some of the soft cast-iron enamels are applied at firing temperatures as low as 700 deg. C., and for use at those temperatures a nickel-free 28 per cent. chromium alloy may be used; but for long service the high-nickel alloys are always preferable.

The absence of scale has several advantages. In the first place there is no risk of anything flying off the pettets on to the enamel and causing a defect. Also, it must be remembered that scale tends to flux brickwork, and there is nothing more liable to eat away a furnace bottom than scale.

Superiority of Castings.

Fig. 6 shows the type of pettet that is being manufactured in large quantities and which is used for general work. It is cast as thin and light as possible, and cannot be said to be designed from an engineering point of view. Fig. 7 shows a pettet for use in a continuous furnace; it has been properly designed to make certain that the creep stress of the material from which it is made is not exceeded. Cast pettets give better service than pettets built up from rolled alloys of the same composition.

The older type of furnace for vitreous enamelling is usually coke or oil fired, and does not incorporate heat-resisting alloys in its structure. In the continuous furnace heat-resisting metals are almost a necessity in various parts of the stationary portion of the structure. There is, however, little doubt but that electric furnaces will ultimately be used for firing enamel ware and heat-resisting alloys will be used in them to a very large extent, refractory materials being used only for heat-insulation purposes.

In the burning of decorations on table ware metal supports somewhat similar to those used in the enamelling industry are used for carrying the ware. As the firing temperature usually does not exceed 850 deg. C., lower-grade alloys can be economically utilised, and alloys Nos. 16 and 22 are quite satisfactory.

In the glass industry heat-resisting alloys are being used extensively for oil-burner tips, reversing valves, recuperators, for parts of glass-bottle machinery and for gathering irons. Whilst oil burners are in operation the air and oil passing through keep them cool, but when the furnace is shut down or if the air supply to a burner fails the tips are subjected to severe radiant heat, and if they are made from steel or cast iron they scale away rapidly and parts made from bronze may be melted. It is hence be-

Table V.—*Properties of Alloyed Cast Irons.*

No.	C.C.	Graphite.	Ni.	Cr.	Cu.	Mn.	Si.	Scaling-Temp.	Brinell.	Yield Point.	Max. Stress.	Elong. per cent.	Red. area per cent.
29	0.58	2.05	Nil	Nil	Nil	—	5.4	850– 900° C.	250	—	10.8	Nil	Nil
30	0.22	1.69	Nil	Nil	Nil	—	10.0	950–1,000° C.	225	—	7.3	Nil	Nil
31	0.38	2.32	Nil	Nil	Nil	—	6.5	850– 900° C.	242	—	—	—	—
32	0.49	1.55	Nil	Nil	Nil	1.0	6.58	900– 950° C.	329	—	6.1	Nil	Nil
33	0.63	1.28	18.7	1.05	Nil	1.17	5.64	1,100–1,150° C.	142	—	7.6	Nil	Nil
34	0.45	1.91	22.7	4.3	Nil	1.20	6.72	Below 800° C.	177	—	9.2	Nil	Nil
35	0.41	2.32	18.0*	Nil	Nil	0.6*	6.0*	,, ,,	101	5.4	6.25	2.25	0.68
36	1.42	1.61	13.0*	2.0*	7*	0.6*	0.2*	,, ,,	197	15.78	17.68	1.75	1.72
37	2.07	0.90	13.0*	4.0*	7*	0.6*	0.2*	,, ,,	266	—	19.48	Nil	Nil
38	1.49	1.98	17.0*	2.0*	8*	0.6*	0.2*	,, ,,	179	13.67	17.72	0.5	—
39	2.13	0.87	22.0*	4.0*	Nil	0.6*	0.2*	,, ,,	212	—	17.92	Nil	Nil
40	1.14	1.34	22.0*	6.0*	Nil	0.6*	0.2*	,, ,,	277	—	25.5	Nil	Nil
41	1.01	Nil	2.0*	28.0*	Nil	0.6*	0.2*	1,000–1,050° C.	285	31.4	36.68	1.5	1.75

* Analysis as charged.

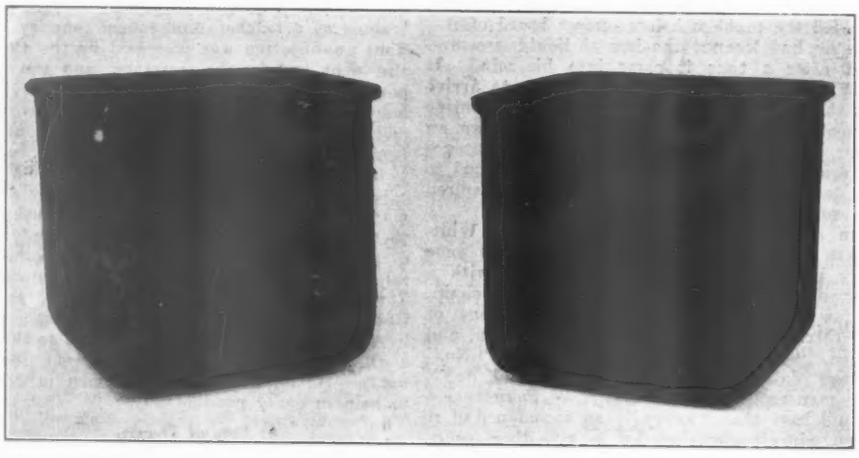


Fig. 5.—Boxes after working in Sulphurous Atmosphere—Left, Special Cast Iron; Right, 20 per cent. Chromium-Iron Alloy.

coming more and more usual to make these parts from a heat-resisting alloy. If the furnace design is good and the burners are reasonably well protected, a low-grade alloy, such as No. 16, is quite satisfactory; but as the cost of the metal only plays a small part in the cost of the finished burner, it is in general advisable to use an alloy containing not less than 60 per cent. nickel and 20 per cent. chromium, such as Nos. 9, 11 or 12.

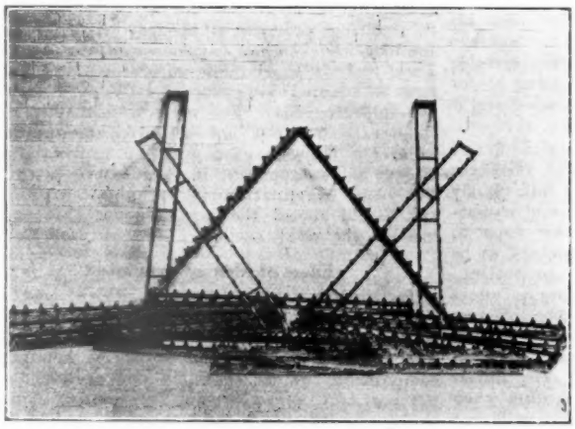


Fig. 6.—Poor Design of Pettet.

Air pre-heaters and recuperator tubes made of heat-resisting metals offer considerable advantages over pre-heaters and recuperators made from ceramic refractory materials. The latter are always extremely fragile, and it is difficult to build them up leak-proof. Also their heat capacity is high and the rate of heat exchange is low

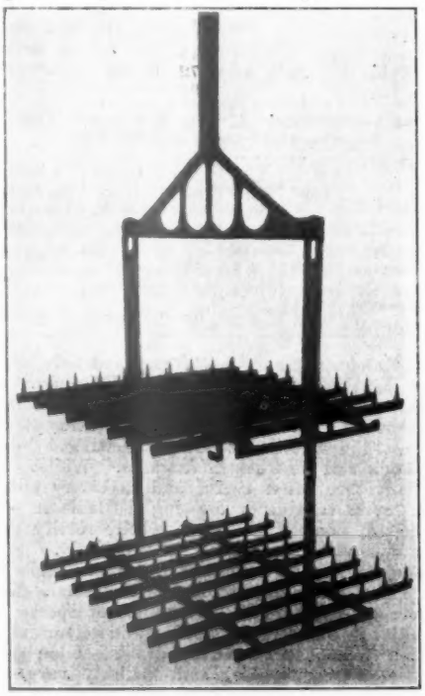


Fig. 7.—Design of Pettet for taking care of Creep Stress.

Metal recuperators have the following advantages:—(1) Light, robust, leak-free construction; (2) low-heat capacity and high rate of heat exchange; (3) indefinitely long life.

If the parts are made from an alloy such as No. 11 and are suitably supported, the working temperature may be as high as 1,100 deg. C. If, however, the parts are particularly thin and not well supported, 950 deg. to 1,000 deg. C. will be the maximum permissible working temperature. As a consequence of the high rate of heat exchange the gas velocity when metal tubes are used can be much greater than when ceramic refractory tubes are used, and the preheater or recuperator can consequently be made much smaller.

For gathering irons a material is required that will resist scaling and yet will easily part from the cooled glass. Although the temperature of the glass is usually above the scaling temperature of the best heat-resisting metal, and may, in some cases, exceed its melting-point, the conditions are really not very severe. The gathering iron does not reach the temperature of the molten glass, and its temperature seldom exceeds 900 deg. C. under usual working conditions. Alloys containing 60 per cent. nickel and 20 per cent. chromium give very satisfactory results and are more economical than gathering irons made from ordinary iron. They usually fail by disintegration, due to the repeated and rapid heating and cooling to which they are necessarily subjected during use.

In glass-annealing furnaces the temperatures encountered under normal conditions vary between 700 deg. C. and 900 deg. C. at the hottest part. In exceptional cases, especially after there has been a break in delivery of the ware, the temperature may rise to over 1,000 deg. C. These conditions can be satisfactorily met by the use of heat-resisting alloys such as Nos. 9, 11 and 12.

Chimney Dampers.

Dampers in main flues have, in the past, usually been made from cast iron. The conditions are, however, sufficiently severe to justify the use of a heat-resisting metal. As sulphur is usually present, nickel-free alloys containing 25 to 30 per cent. chromium are the most economical. Kiln fans should always be made from a heat-resisting metal. If sulphurous gases are present a nickel-free alloy should be used, but in some cases it may be necessary to use a metal with a higher creep-resistance, such as alloy No. 16.

The future of heat-resisting metals, even if their properties are not further improved, is assured. Apart from bad trade, the factors preventing their immediate utilisation for the many purposes for which they are technically well fitted are general lack of knowledge of their properties—and even their very existence—and their comparatively high cost. Alloys are available which have a useful strength at temperatures up to 1,000 deg. C., and which can be used at temperatures as high as 1,200 deg. C. if properly supported by ceramic refractory material. The price of heat-resisting alloys is influenced to a very great extent by the price of nickel, which is an essential constituent of the highest quality metals. It is unfortunate that the nickel producers cannot evolve a much less expensive method of production than the ones now in use, all of which give an unnecessarily pure product. The advent of cheap nickel which might contain up to 0.5 per cent. carbon, 0.5 per cent. silicon, 1.0 per cent. manganese, 10 per cent. iron, together with small percentages of tungsten, molybdenum and aluminium, would be a very big factor in hastening the utilisation of heat-resisting alloys to a greater extent than at present.

Apart from a detailed study of the properties of the known alloys, research workers are seeking to increase the strength of nickel-free alloys and to eliminate the brittleness which characterises most of them. The Al-Fe, Cr-Fe, Cr-Al-Fe and Cr-Mn-Fe alloys are the subjects of much attention at the present time, and the author feels that it is amongst them that the alloy of the future will be found. Production methods are being investigated and heat-resisting metals melted in vacuum are already available. Melting in hydrogen or nitrogen atmospheres has also a profound effect upon many metals and may be utilised on a practical scale in the near future.

In conclusion, the author would express his appreciation of the permission of Messrs. Darwins, Limited, in whose laboratories and works much of the practical work has been done, for the publication of this Paper.

The German Foundrymen's Technical Association.

MEETING IN BERLIN.

A meeting of the German Foundrymen's Technical Association will be held on November 12 and 13 at Berlin, when the following programme will be carried through.

Saturday, November 12.

In the old Physics Lecture Theatre of the Technical High School, Main Building, Berlin-Charlottenburg.

Morning.—"Recent Investigations on the Formation of Graphite Nuclei in Cast Iron," by Prof. Dr.-Ing. E. H. Schulz; "The Pearlite Field in the Maurer Cast-Iron Diagram, for Wall Thicknesses of 3 to 90 mm.," by Prof. Dr.-Ing. H. Uhlitzsch; "The Present-Day Position of the Production of High-Grade and Short Annealed Malleable Iron in the United States," by Dr.-Ing. H. Kipper; "A Review of the Latest Development of Cast Iron," by Dr.-Ing. G. Meyerburg, and "Martensitic Cast Iron," by Dr.-Ing. R. Hanel.

Afternoon.—"Modern Gas Producers and Open-Hearth Furnaces" (duration of lecture 50 min.), by Engineer O. Beckmann; "Experience with the Murx Oil-Fired Cupola," by Prof. Dr.-Ing. E. Piwowarsky; "The Behaviour of Chills and Chaplets during Casting in Cast Steel and Cast Iron," by Dr.-Ing. E. Lanzendörfer; "The Rolling and Hot Deformation of Cast Iron," by Dr.-Ing. H. Kipper.

In Lecture Hall No. 203 of the Iron Metallurgy Institute of the Technical High School (Chemical Building), Berlin, a non-ferrous session is to be held.

Morning.—"High-Grade Large Cast Patterns of Aluminium Light Alloys," by Dr. W. Claus; "Can the Brinell Hardness give Information about the Resistance of Bronze and Brass to Wear?" by F. Brobeck, and "The Effect of Gases on Alloys of Bronze," by Dipl.-Ing. Fr. B. Bauer.

Afternoon.—"The Mechanism of Contraction Piping: Mathematical Consideration of the Problem of Piping," by Dr.-Ing. F. Goederitz; "Recent Results with Green Casting in Non-Ferrous Foundries," by Chief Engineer H. Buschmann; "The Making of Brass Castings by Pressure," by Dr.-Ing. Brunnckow, and "Die Casting," by Chief Engineer Rössler.

Sunday, November 13, 1932.

In Lecture Hall No. 301 of the Technical High School, Main Building, Charlottenburg.

Morning.—"Why use Economic Statistics in Foundries?" by Dr.-Ing. E. Matejka; "Coal Dust in Moulding Sand," by Prof. Dr. P. Aulich; "The Preparation of Moulding Sand in Combined Plants," by Dr.-Ing. A. Rodehüser; "A French Moulding Process without Boxes," by H. Buschmann.

Following the technical meeting a number of lectures will be given in the Technical High School on the "Position of X-Ray Technique in regard to Foundry Practice, with Practical Demonstrations." These will be held on Monday and Tuesday, November 14 and 15.

Cause and Effect in Bronze Founding.*

By Francis W. Rowe, B.Sc., M.I.M.M.

The production of a sound bronze casting having physical properties approaching the maximum of which the alloy is capable is an accomplishment of no mean order, even with a casting of relatively simple shape. It is to be feared that this ideal of a casting really sound and dense in every portion is one that is reached in only a small proportion of the large number of castings made every day in this country, and it is to be feared also that this state of affairs is largely due to complacency and ignorance of what the alloy concerned is capable. It must be admitted that with the majority of types of bronze castings the inherent strength and soundness usually associated with forged or otherwise wrought products is difficult of attainment, yet with care and understanding of the basic principles involved much improvement over the average every-day commercial article is possible.

Lighter and Better Castings.

It is the author's belief that the last few years, particularly, have seen considerable improvement in this respect, due to several causes. The present-day intense competition has resulted in a probably much-needed jar to the traditional British policy of building heavily and building safely—that is, machines and manufactures sufficiently large and heavy to mask out any possible deficiencies in material—particularly castings. This present-day infection for paring the weight of castings both for economy and to give a lighter weight per horse-power has resulted in unrealised deficiencies in castings and cast materials being revealed, and the engineer is now demanding and obtaining a higher standard in this respect.

Then, again, this—to the designer—comparatively sudden revelation of the shortcomings of many commercial castings has led to the introduction of forged and other parts where a few years ago the casting was the only commercially practicable proposition. Some of this transference to the forged or other product is logical, and constitutes a definite improvement, but in many instances it is unwise and unnecessary if the founder will explore and exploit the possible avenues for improvement of his product. It is not sufficient to-day for the founder to satisfy his *amour-propre* with the knowledge that his product is as good or better than the average if the casting is not definitely entirely suitable for the work it has to do, or if by using better materials or better methods of manufacture it can be improved.

These tenets hold good with force in the art of bronze founding, and whilst in many instances the paths of progress are anything but clearly delineated, it is only by close study and experimentation by all of us that we can hope to eliminate defects and weaknesses now apt to be regarded as inevitable in the bronze casting. Whilst for some compositions of bronze alloys the question of the purity and type of raw materials is of more importance than others, yet the ultimate soundness and strength of all of them is materially affected by the initial composition of the charge. The millenium when silk purses can be made from sows' ears is not yet appreciably closer in bronze foundry practice.

The production of really high-grade castings from secondary or scrap raw materials is a matter of infinitely more difficulty than with virgin, basically pure metals. In some cases it is the form more than the composition of the scrap which renders it less valuable than new material. For instance, scrap copper wire, if unburnt, is of unquestionable purity, yet the difficulty in ordinary types of furnaces of melting it without appreciable oxidation and gas absorption is much greater than with ingot material.

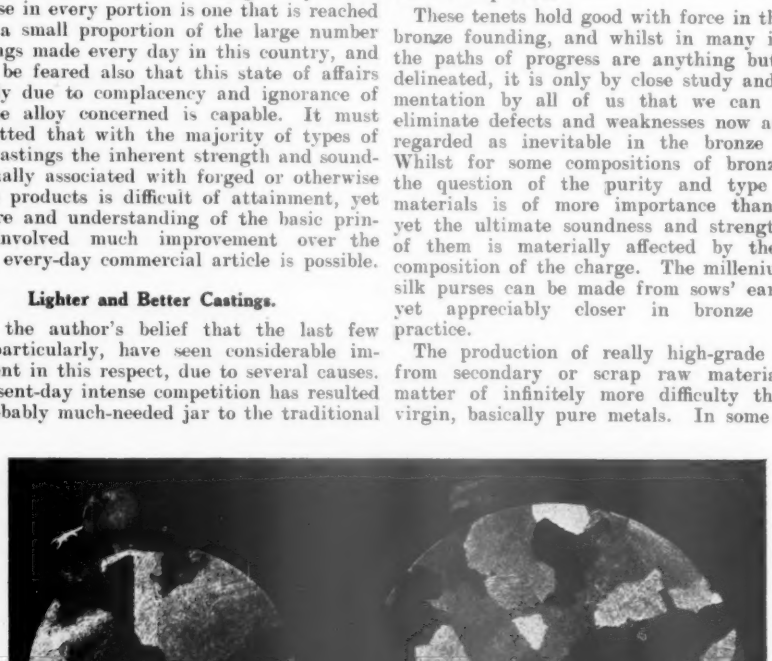


Fig. 1.—Effect of Mass on Grain Size of Sand-Cast Bars Cast at the same Temperature.

Faulty Melting.

It may be said at the outset that possible 50 per cent. of the troubles that bronze castings are heir to are due at some stage to faulty melting conditions. A well-known instance, with which most bronze founders are familiar, and which offers a fruitful field for reflection and study, is that of pure copper castings destined for electrical purposes. The absorption of gas here in practically any type of melting furnace and the impossibility of using any of the common and most efficient deoxidisers and degasifiers for its elimination render the problem one needing nice judgment and careful methods. The presence in the final castings of even small quantities of the most efficient aids to soundness, such as zinc or phosphorus, lowers the electrical conductivity too markedly to permit of their use.

Those elements such as silicon, boron and cadmium which are permissible in small quantities are by no means so powerful in preventing absorption or liberation of gases, and most careful melting practice is needed. Every bronze founder who has had experience of this class of work realises that unless careful melting practice is adopted even superficially good results are impracticable. Yet with bronze alloys the same care is often not bestowed, because the difference between good and bad melting practice is not so apparent in the finished castings. Yet close examination of the physical properties would reveal the big influence this phase has on the final results.

Effect of Melting Conditions.

To illustrate the difference which may be present, the author prepared two comparative sets of castings from which test-bars were cut. The material was phosphor bronze of Admiralty composition, 10 per cent. tin and aproximately 0.3 per cent. phosphorus. Two similar moulds were prepared in dry sand and two one-hundred pound charges were melted. The charges were similar in composition with the exception that the copper in one instance was clean electrolytic wire scrap. The tin in both cases was English refined ingot and the phosphorus added by means of 15 per cent. phosphor copper.

In one instance the charge was melted in 45 minutes in a preheated crucible covered and alloyed in the correct manner. In the other the charge was melted in a cold crucible under poor conditions, and was in the fire 2 hrs. and 25 min. The moulds were poured at the same temperature. The difference in the two castings is amply illustrated in the figures shown in Table I. Both were, of course, apparently sound and similar on machining, and only tests such as these would reveal the difference. It should be realised also that it is much more important to melt correctly than to attempt to correct the errors due to bad melting by deoxidants and nostrums afterwards. Whilst deoxidants are often useful and necessary additions after tapping or drawing the ladle or pot of metal, none of these can wholly rectify the mistakes which have occurred previously.

Table I.—*Showing the Effects of Melting on the Physical Properties of Admiralty phosphor Bronze.*

	M.S. tons/in.²	Y.P. tons/in.²	E. per cent.	Density (Corrected).	Brinell Hardness. 1,000 kg.
Correctly melted	19.9	9.2	21	8.43	72
Incorrectly melted	15.8	9.3	11	8.27	65

The errors of bad melting are often visible to the naked eye in the fracture of the metal. The presence in gun-metal and bronze of specks is familiar to all of us. These vary in colour from golden yellow to rust red, dependent on the degree of the trouble, and similarly vary in quantities from occasional specks to the worst stage where they permeate practically the whole of the fractured face. They are generally, but most probably wrongly, called oxide inclusions for want of a more correct designation.

They constitute definite discontinuities between the crystal faces and the strength of the bronze is proportionately lessened as the number of these discontinuities increases. No bronze containing them in appreciable quantities can be expected to give good results as regards physical tests, density or soundness.

Ideal Melting Practice.

The ideals to be aimed for in good melting practice are, first, rapid melting time to prevent undue exposure to gases or air either in

* Paper read before a meeting of the East Midlands Branch of the Institute of British Foundrymen, Mr. C. W. Bigg presiding.

the early stages when the metal is likely to suffer from heavy surface oxidation, or in the later stages when progressively increasing amounts of gas are likely to be absorbed.

This can only be secured by having the crucible or furnace very well preheated before the charge is loaded. For all ordinary bronze work a furnace or crucible temperature of from 1,300 to 1,350 deg. C. should be the minimum aimed at. The furnace or crucible should also have a big reserve of heat with the idea of securing rapid transference to the charge. It has been found that a reducing atmosphere contributes largely to heavy gas absorption in the molten metal, and the general trend of present opinion is that a slightly oxidised atmosphere is to be preferred in view of this danger. The charge should, to counteract the effects of this slightly oxidising atmosphere, be kept covered with charcoal.

In bronzes and high tin gun-metals the appearance of the runner heads after solidification often forms an indication of the correctness or otherwise of the melting. Given reasonably correct casting temperature, the heads should present a slightly sunken appearance without any beads of "tin-sweat." Due to reasons as yet imperfectly understood, liquation takes place more readily and freely in a bronze which has large amounts of gas in solution.

Rate of Solidification.

Probably the next most important question in securing sound bronze castings is that of rate of solidification, with which is intimately bound up the questions of mould material and condition, runner size and casting temperature. It is impossible to consider any one of these items without relation to the other.

The smallest grain size, the greatest hardness, and with limitations, the highest density, all result from the most rapid rate of solidification. Other things being equal, the lowest casting temperature gives the most rapid rate of solidification. Obviously, also, the smaller the mass of the casting and the greater surface area, other things being equal, the more rapid the rate of solidification. The question of mould material also profoundly affects the rate of solidification. Between a water-cooled copper mould and a dry-sand mound at an elevated temperature, a wide range of solidification speeds is possible. Runner and riser size and position and the distance the metal must travel in the mould also affect the rate of cooling of the molten metal.

It is understandable, therefore, that all these variables must be taken into consideration, and experimented with if necessary, for each particular type of casting and alloy.

It would take too long to do more than touch the fringe of these various points, but the following concrete illustrations from practical results give a guide to the fruitfulness of studying these variables.

Fig. 1 shows the effect of mass on grain size, being the etched cross-sections of three bars, respectively 2.5-in. dia., 1.5-in. dia. and 0.80-in. dia., cast at the same temperature. The varying physical properties of these three bars are shown in Table II. All conditions except those of mass were identical.

TABLE II.—*Physical Properties of Three Bars Cast at 1,200 deg. C, in Alloy 89.5 per cent. Cu. 10.5 per cent. Sn.*

	Density.	Brinell Hardness.
Bar, 2.5 in. dia.	8.37	65
Bar, 1.5 in. dia.	8.42	68
Bar, 0.8 in. dia.	8.55	72

To take another instance illustrative of the effect of varying mass. Three rims were cast under similar conditions in phosphor bronze. Each had test-bars attached and the moulds were cast at the same temperature. The results, very illuminating from several points of view, are shown in Table III. They show another

TABLE III.—*Effect of Mass on Phosphor Bronze Rims Cast with Test-Bars Attached.*

	M. S. tons/in².	E. per cent.
Rim, 14 in. O.D. by 10 in. bore by 1½ in.	15.5	7.5
Test-bar attached	17.8	15.0
Rim, 14 in. O.D. by 10 in. bore by 2½ in.	14.25	7
Test-bar attached	18.25	17.5
Rim, 14 in. O.D. by 10 in. bore by 3½ in.	13.6	6
Test-bar attached	18.3	19

feature which needs prominent consideration in bronze foundry work, namely, that the test-bar is no real criterion of the physical properties of the casting to which it is attached and can only be used as determining the quality of the metal from which it is cast.

Density tests, where practicable, and they are practicable in many more instances than is generally appreciated, form one of the most useful guides to the soundness of a bronze casting. Density determination even on small and

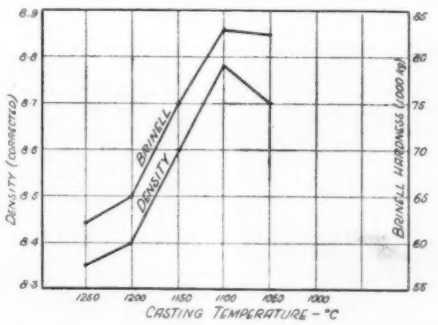


FIG. 2.—EFFECT OF CASTING TEMPERATURE ON DENSITY AND HARDNESS OF SAND-CAST 90:10 BRONZE.

medium castings are comparatively easy to make with reasonable accuracy sufficient for the purpose. The density of the gun-metals and bronzes does not vary a great deal with variation in composition except, of course, the heavily-leaded bronzes. Density figures vary from 7.8 in an unsound bronze casting—but not necessarily one with patently visible porosity—to 8.85 in a centrifugal casting made under the best conditions. In connection with this, it should be remembered that the lowest casting temperature which gives the smallest grain size often adversely affects the density under commercial casting conditions.

Fig. 2 shows typical curves covering hardness and density of a bronze alloy cast in dry-sand moulds showing the effect of casting temperature. Furthermore, it will be usually found with normal foundry conditions that it is not possible to work at the most rapid rate of solidification with sand moulds, *i.e.*, at the lowest casting temperature necessary to give the greatest hardness and density. Contact of hot metal with even a perfectly dried mould results in the liberation or formation of some gases. If the metal is on the point of solidification on entering the mould, then it has not the opportunity to recover, and superficially or subcutaneously unsound castings result.

Liquid Shrinkage.

The question of adequate compensation for liquid shrinkage is one of great importance. Since in most instances rapid solidification, which can be secured by chills or chill moulds, seems to offer the best solution to the problem of securing sound and dense castings in bronzes, it would seem logical to presume that this would be the best avenue of approach in most instances. Yet this is not so. The difficulty of providing for adequate feeding for bronzes where the mould is of such a character that practically instantaneous freezing takes place is one of great difficulty where anything approaching complicated sections are concerned.

Probably the problem in bronze founding which calls for the exercise of most judgment and where experience is most valuable, is that of producing a casting of varying section and complicated design where the metal is uniformly sound and varies little in physical properties in thick and thin sections. No definite rules can be laid down to cover all cases. In general, it is preferable to run such castings in the thinnest sections and place adequate feeding heads on the heaviest sections. This gives the thinnest sections the benefit of the hottest metal. Where, due to their location in the mould it is not possible to feed heavy sections, it is often possible to secure greater soundness by embedding chills in the sand to partially unify the rate of solidification.

Local Unsoundness.

Local unsoundness or porosity consequent on uneven section and inadequate feeding whilst troublesome and sometimes inconsistent is usually a bogey which can be overcome if methodical methods are used to eliminate it. Even microscopic porosity of the order which gives trouble only under severe pressure tests can have the cause located if handled logically. Frequent sectioning of castings and careful exploration of the varying hardness by the Brinell machine is a much more satisfactory and illuminating method than merely ringing the changes on runner and riser position and size without a clear understanding of what is occurring. Whilst possibly more expensive in the initial stages, if the evidence thus obtained is collected and studied, an experience is built up which renders the solution of later problems of a similar character much quicker.

So far, nothing has been said as regards the effect of composition and impurities (except those introduced through faulty melting) on the problem of securing sound castings in the bronzes and gun-metals.

In a well-conducted bronze foundry really setting out to produce a quality casting, the troubles due to incorrect composition or impurities should be of a much less order than those associated with the melting or moulding practice. The problem of impurities is not one which worries a foundry using high-grade raw materials except where contamination of shop scrap may occur.

Where various alloys, including those of aluminium and white bearing metals, are made, extreme care is, of course, needed to prevent mixing. The presence of even small quantities of aluminium is, as is well known, very detrimental to gun-metals and bronzes, particularly those which are to withstand high test pressures. Antimony resulting from white-bearing-metal contamination adversely affects the physical properties, particularly the tensile strength and ductility.

Absorption of sulphurous gases either due to poor coke or high-sulphur-content fuel oil has also been responsible for much trouble in the bronze foundry.

A sulphur content of much more than 0.03 per cent. in a bronze causes excessive shrinkage and porosity, probably due not to the sulphur itself, but its indication of excessive SO_2 gas dissolved in the metal. It is well to remember also that the trouble due to gas absorption, either sulphurous or otherwise, is more pronounced in nickel-bearing bronze—even a nickel content as low as 2 per cent. will appreciably increase the susceptibility of a bronze to defects arising from this source.

(*Concluded on page* 292.)

Large Hollow-Forged Reaction Chamber.

CLAIMED TO BE WORLD'S LARGEST HOLLOW FORGING.

Messrs. Thos. Firth & John Brown, Limited, Sheffield, have just completed the manufacture of what is claimed to be the world's largest hollow-forged reaction chamber for use with a Dubbs cracking unit.

An undertaking of this character implies very advanced hollow-forging technique. At the initial stage an ingot of 170 tons was cast at the Atlas works of the company from three open-hearth acid furnaces, and after certain processes under the 6,000-ton forging press was taken to the heavy-machine shops, where a 25½-in. hole was trepanned through it. The trepanned ingot was then expanded in diameter under the 6,000-ton press, and the drawing process then commenced. During this process the mandrel used, together with the balance weights and the chamber in its rough state weighed 326 tons. In due course the open-ended forging was put into an 82-in. centre lathe, and then transferred to a 48-in. lathe with a 70-ft. bed, where it was bored for its entire length. As some indication of the accuracy of the forging operations, it may be mentioned that the finished bore machined to 71¼ in. from a forging which measured 69½ in. internal dia. In other words ¾ in. of material alone had to be removed.

In the initial forging operations "swells" had been left at each end of the chamber, and these were now closed under the 6,000-ton forging press to the required shape. The next stage consisted of heat treatment in one of the furnaces which have been developed for this class of work. The uniformity of the material in the ingot was demonstrated by the fact that test results taken from bottom and top of extreme ends yielded only a difference of half a ton per sq. in. maximum stress.

The final machining in a 50-in. lathe, together with the drilling of 20 bolt holes in each end flange completed the engineering operations. The finished reaction chamber has an overall length just over 48 ft., an outside diameter of 78¾ in., inside diameter of 71¼ in., and its approximate weight is 66 tons.

Fig. 1.—View of Hollow Forging with Ends Closed ready for Machining.

Fig. 2.—Finished Forging ready for Dispatch.

The Davenport Locomotive & Manufacturing Corporation, of Davenport, Iowa, installed one pair of shear blades made from Edgar Allen Double Seven shear blade steel. These have been in continuous service since the year 1929, cutting all S.A.E. steel on a 3-in. capacity shear. They have cut to date over 2,000 tons of steel with one grind. This is believed to be a record. The materials cut with the blades varied from S.A.E. 1025 to 1030 (0.25/0.30 carbon steels), and also included some of the 3135 (nickel-chrome steel) and 2335 (nickel steel) steels. The majority of the cuts were approximately 8 in.; but some were shorter and some longer.

Foundry Problems.*

DISCUSSION.

Mr. McClelland, after congratulating Mr. Howe, explained that there was another reason for casting a hydraulic cylinder "on-end" besides that of cleanliness. Such castings had to be sound and consequently were best set up without the aid of chaplets. The references Mr. Howe had made to locomotive cylinders referred more to dry-sand moulding than to green sand.

Mr. C. Edward Williams, Vice-President of the Institute, said he would also like to thank Mr. Howe particularly for discussing failures rather than successes. It was from failures that one was able to learn something. He had referred to the use of pyrometers, and in considering metals one should also take into consideration the state of the daylight at the time of the test. There were some very good pyrometers which can be of very great help to founders. Some troubles, too, have been overcome by the use of soda-ash or Thermit, and it would be helpful if any members present could pass opinions as to the value of these two substances.

Mr. Ben Hird said that he had found soda-ash very useful for the elimination of sulphur, but, on the other hand, it created much more slag on the top of the molten metal, necessitating considerable time being spent in its removal. With regard to Thermit he did not think this was much used now. His only experience of this was many years ago, and had proved very unsatisfactory. It certainly "livened up" the appearance of the metal, but it gave porous castings. Referring to phosphorus, he agreed with much Mr. Howe had said. In common with many other impurities in cast iron, phosphorus had both supporters and detractors. Some specifications limited this content to 0.5 per cent., which was a mistake, as much higher percentages of phosphorus were used successfully for cylinder work. Mr. Cook put his finger on the root in a recent Paper before this Branch when he explained that a great deal of trouble with phosphorus was caused by its solidification in the final structure, and that accounted for many of the variations of opinions of analytical chemists and foundrymen. The microscope should be the proper guide and prove more helpful than chemical analysis. One peculiar experience might prove interesting. In the making of railway chairs much trouble had resulted from the use of low-phosphorus iron. Upon analysis this iron was shown to contain 0.2 per cent. phosphorus.

Mr. W. R. D. Jones said that "eating in" was caused when the phosphorus segregated, but not when this element was properly distributed throughout the mass.

Mr. Kinsman asked whether bars in the moulding boxes would not have eliminated the trouble with the phosphor-bronze castings to which he had referred, and it was agreed this would have been so.

In reply to a question from the chair, Mr. Howe said that in India he had used machine-cast pig-iron, which had not been a success, but he saw no reason why there should be any difference in the ultimate results when using either machine- or sand-cast pigs. Actually, the machine-cast should be the better. With regard to Mr. McClelland's point, he had not referred to hydraulic cylinders, because they lend themselves to casting on end more than others do.

Mr. R. J. Richardson, in proposing a vote of thanks, said that to rely absolutely upon analysis was a fallacy. There should be a combination of this with the use of the microscope and practical experience.

In seconding this, Mr. W. R. D. Jones pointed out that if the sample submitted for analysis was not representative, it was not the fault of the chemist. If the chemist were allowed to take his own sample, it would be better.

* See Foundry Trade Journal, November 3, 1932.

Catalogues Received.

Microscopes.—Messrs W. Watson & Sons, Limited, 313, High Holborn, London, W.C.1, have sent us a copy of their latest 32-page pamphlet, which covers instruments suitable for the examination of sand. The major portion of the catalogue is taken up with an item-by-item description of the "service" microscope. This is an excellent notion, as the instrument is marketed mainly for the use of students. We notice on the inside back cover a list of the publications issued by this house, and the ones which would interest our readers the most is Parts 4 and 5 of their catalogue of microscopes and accessories. Part 4 covers metallurgical microscopes and Part 5 photomicrographic cameras and accessories. On page 32 there is described and illustrated a Universal Binocular Microscope. If this could be attached to a metallurgical microscope it should show some advantages, but we are not at all sure that this is possible.

"Sirocco" Products.—In printing this heading, we have broken one of our rules, because of our inability to find a caption covering all the manufactures of Messrs. Davidson & Company, Limited, Sirocco Engineering Works, Belfast, as set out in their latest catalogue "Sirocco" Products, without being unduly pedantic. This 8-page brochure illustrates and very briefly describes centrifugal, propeller-type, induced-draft, cupola, mine and screw pans; air heaters, conditioning units, dust-collecting equipment; pneumatic-conveying plant and tin machinery. Now all these excellent illustrations have either beneath or near by an indication of the appropriate catalogue covering the type of product shown. The back page is devoted to the family tree of the Sirocco organisation, starting at Belfast and reaching right through Britain and the Continent to Java. As a means of introducing the products of a firm making a large variety of manufactures we can envisage no better means, and we compliment whoever is responsible upon both the idea and its presentation.

Steel Furnace Charging Boxes.

By Sample Passer.

Fig. 1 of the accompanying line drawings shows a design of charging box used for charging stock into steel furnaces by means of the electric charging machine. These boxes consist of the following material:—Two side plates marked *a*, Fig. 2; one end plate marked *b*, Fig. 1; one bottom plate marked *c*, Fig. 1, and one casting *d*, Fig. 1.

The purpose of this article is to describe the tackle used and the method employed to form the side and end plates to take their respective positions as shown in Fig. 1.

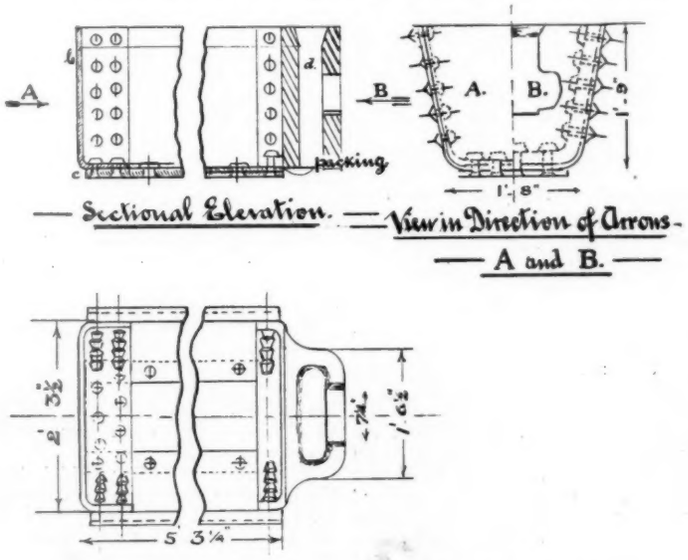


Fig. 1.—General Arrangement of the Charging Box.

The plate to be bent is heated its full length and approximately 14 in. in width and placed between the former bracket and back plate and the rail swung to the position shown at *k*, Fig. 2, located at both ends inside the slotted steel plates or brackets already bolted at each end of the former bracket as shown. Wedges L are now driven home tight between the rail and the back plate, bringing the latter to a full-closed position. The plate is now ready for hammering to shape.

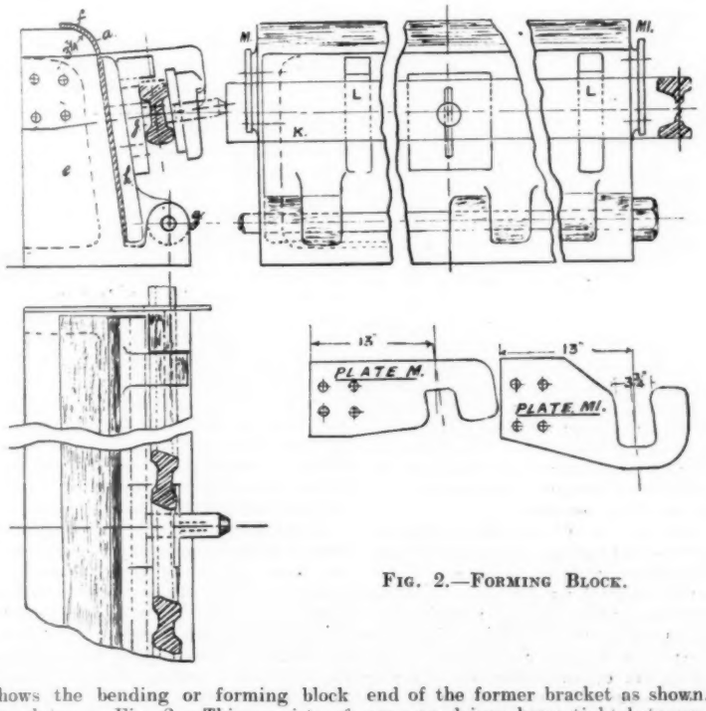


Fig. 2.—Forming Block.

Fig. 2 shows the bending or forming block for the side plates *a*, Fig. 2. This consists of the cast-iron former bracket *e*, shaped on face *f*, to the radius shown; hinge brackets or lugs *g* are cast on this bracket to engage in similar brackets cast on the back or cover plate *h*. Trunnion *j* is riveted on to the cover plate *h* in the position shown, and a piece of bull-nose rail 6 ft. 6 in. long by 5¼ in. by 2¾ in. is drilled to match this trunnion as shown, and held in position by the cotter pin as indicated.

Fig. 3 shows the end plate developed, the outline of this plate is cut to shape with the oxy-acetylene burner, also the corners marked 1*a* and 2*a* indicated by the sectional lines.

Fig. 4 shows a very simple and effective device for bending these plates along the hatched lines.

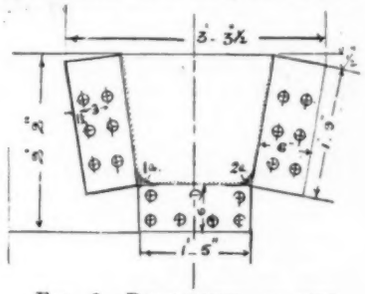


Fig. 3.—Development of the End Plate.

The castings 3 and 4, Fig. 4, are made in outline the exact size of the finished box, minus the plate thickness. Allowance is made at the end marked 5 when fixing the centres for the hinge pin to clear the thickness of the plate at this point when operating the lever marked 6 to liberate casting 3 when fixing the heated plate in position for bending the two sides and bottom to shape.

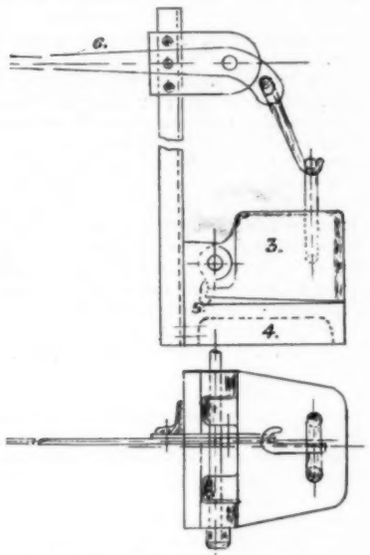


Fig. 4.—Plate-bending Device.

The steel plate shown in section at *a*, Fig. 5, takes the place of the end plate referred to for the open-end type of charging box. The cast-iron mandrel block shown in this figure is made to the internal dimensions of the box less the thickness of the plate. The plate when heated is held in position by the two cotter pins shown, and hammered to shape; after this is done the two cotter pins are released and the plate removed.

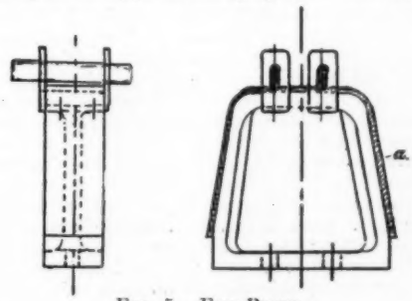


Fig. 5.—End Plate.

Manufacture of Cast Iron in the Rotary Pulverised Fuel Furnace.*

By Dr. P. M. MacNair.

Cast iron, on account of its cheapness and the ease with which it can be melted and cast, together with the facility with which it takes a true and sharp impression of the mould, finds very wide and varied applications in the arts and in industry. The continued advance of engineering design and the demands for better and stronger metal, and the competition of other metals and also the competition of fabricated articles by welding and other methods, has stimulated founders to improve methods of production. The production of castings consists of two main departments:—(1) The production of suitable metal, suitable for casting, (2) the production of moulds into which the molten metal is poured. The two operations are intimately related since good metal must be suitably handled by the founder after the mould is prepared, and poor-quality metal cannot give good-quality castings however good the mould may be. It is therefore only natural that metallurgists and founders, working in co-operation, should continually strive to produce castings of increased strength and reliability.

There are several methods of producing cast iron sufficiently fluid to run into the moulds, but by far the most commonly used is the cupola. The cupola has taken a prominent place because of its simplicity of operation, low initial installation cost and cheapness of running cost. Under careful control it can produce a wide range of composition suitable for a great variety of castings. Even although the cupola does form such a successful unit, it is only natural that investigation should take place in order to determine if its efficiency can be increased. As a consequence, is such progress in design as shown by the Poumay cupola, the Griffin hot-blast cupola and the balanced-blast cupola of the British Cast Iron Research Association, to mention but three. In other cases increased efficiencies have equally been obtained with the cupola, as it stands, by a more accurate scientific control of charging and control of the quantity and pressure of the blast going to the furnace.

Cast iron is also melted in crucibles, air furnaces, open-hearth furnaces and the electric furnace. Generally speaking, the development of these optional types is due to the desire to get qualities of iron which are difficult to make with certainty and regularity in the cupola. The control or analysis and physical properties which can be exercised is much greater, giving the consequent advantages in the finished castings. This is to a large extent due to the isolation of the molten metal from the action of the fuel and of the combustion gases, which is possible in the reverberatory furnace. The demands for greater heat in this type of furnace have successively been met by the use of a long-flaming coal, burning of regenerated hot gas and air using the well-known Siemens principle, electric heating and by oil firing. Within the last few years, however, the technique of burning pulverised coal has been improved to such an extent that it now forms a most economical means of generating the necessary heat in the reverberatory furnace.

It is well known that powdered fuel can give a very hot intense flame such as is suitable for metallurgical work. At the same time the development of this new fuel allowed for the development of a more efficient type of combustion chamber which has given additional advantages. The combination of the two has given the foundry trade a new melting unit, which is known as the rotary pulverised-fuel furnace or specifically under the name of the firm or individual who have perfected special types. There is the Brackelsberg furnace patented in this country in 1927, the Sesci furnace for which patents were taken out two years later and also the Sklenar & Buess, subsequent to the above. As the general construction and method of operating the furnace is probably known to most members, it is proposed to deal more specifically with the principles underlying the advantages which have come from the development of the rotary pulverised-fuel-fired furnace.

* A Paper read before the Edinburgh Section of the Institute of British Foundrymen, Mr. W. Wallace presiding.

Economic Production of High Temperature.

The production of higher temperatures has been one of the most important features in the history of the development of metallurgical processes. Pre-historic man had his primitive open grate, later he learned to build shafts or chimneys up a hillside which increased his draft, subsequently he used forced draft from bellows worked by foot or hand. Then there was a long period of improvement in these primitive plants, with the important change from wood and charcoal to coal and coke as fuel. Gases from the distillation or semi combustion of coal were used to replace the solid material, and a further advance made by preheating both the gas and the necessary air for its combustion by regeneration from the heat of the waste products. Oil heating has had some applications within recent times and the most powerful source yet developed is from electricity either in the arc, resistance or induction type of furnace, where temperatures up to 2,500 deg. C. can be obtained.

Oil and electric firing are very expensive per unit of useful heat generated so coal has maintained its pre-eminence as the heat-producing raw material. Generally speaking, for metallurgical work, coal has to be prepared for burning in the furnace proper by partial combustion outside on a grate, in a gas producer, or in a coking oven, so that a proportion of its available heat is lost so far as the useful purpose aimed at is concerned. By using the coal pulverised form, however, all its heat units are developed in the furnace proper and can be utilised to give greater efficiency. The perfecting of the use of pulverised coal has given a ready means of producing very high temperatures at a reasonable cost, as the running and maintenance costs on the plant required for fine grinding are only about 2s. 6d. per-ton of coal, which is offset largely by the greater heat efficiency and by using the fines from the colliery, which can be obtained at a cheaper rate than through coal. In addition to generating its heat units in the furnace proper, powdered coal has the additional advantage that it can readily be completely burned, using only a very small excess of air. This gives higher temperatures, since there is the minimum of inert nitrogen and excess oxygen and waste gases, which absorb considerable amounts of heat in themselves, thus cooling down the flame temperature.

Advantage can also be taken of the possibilities in preheating the fuel and air required for combustion by regeneration from the waste gases. It is not possible to heat up the pulverised coal beyond its ignition point before reaching the burner, otherwise combustion would take place too early. Accordingly only a fraction of the air, say 20 to 30 per cent., is used for carrying the coal to the burner in a primary stream which has its temperature limited to about 350 deg. C. for bituminous coal and 450 deg. C. for anthracite. At the burner secondary air for complete combustion from a separate pipe is allowed to mix with the primary air and coal. This secondary air can thus be preheated to any conveniently available temperature. With pulverised coal it is therefore possible to get a very high flame temperature with generation of the maximum heat units in the proper zone, that is, in the furnace itself, at a cost competitive with the cheapest obtaining at the present moment.

Economic Use of the Heat Generated.

The production of a high flame temperature is of primary importance, but there is an equally important factor in the volume of furnace available in which combustion may take place. Furnace design is bound up with the heat release per unit of volume or, as it is called, the calorific intensity. If the volume is too great, obviously the heat intensity is smaller and the proportion doing useful work in melting, less. By reducing the volume a greater intensity is obtained. There is a limit to this, however, which is determined by the resistance of the refractory to break down. With a very high intensity of the order of 700,000 B.T.U. per cub. ft. per hr. it is not possible to radiate heat through the refractory sufficiently quick to prevent the temperature of the inside of the lining rising to a point where the refractory begins to melt.

In practice, however, the intensity is limited by the necessity of having sufficient volume to hold the required quantity of metal. As a consequence of this the heat release is of the order of 100,000 B.T.U. per cub. ft. per hr., which is very satisfactory when compared with other melting practice.

In addition to giving a high heat release in the minimum space, the rotation of the furnace helps considerably in the economic utilisation of the heat. In ordinary reverberatory-type furnaces, heat is transferred to the charge mainly by radiation from the roof and the flame. It is because of its radiant power that the smelter likes to see plenty of body in his flame and not a colourless one. With rotary furnaces, in addition to the above two sources, the hot lining transfers heat by conduction as it passes below the metal surface. The lining is again superheated as it comes in direct contact with the flame. This action has an additional value in cooling down the lining, thus minimising wear and tear on the refractory.

High-Temperature Iron.

The production of high flame temperatures and the efficient use of the heat generated represents the fundamental advantages of the rotary furnace from the operation point of view. Before dealing with the consequent metallurgical advantages, the effect of these on actual operation may be indicated. The furnace is always ready for melting and can be started at a moment's notice by turning on the pulveriser, with a small wood fire at the entrance. The flame strikes very quickly even when the furnace has been lying idle for days and a cold charge has been put in. Owing to the cold furnace and heavy radiation losses, the flame is dull red and cold itself at the start, while it is possible to burn only half-load. Within half an hour, however, it is beginning to brighten up, and a partial turn is given to the furnace. This turns over the charge and exposes fresh cold surfaces, with a consequent dulling down again of the flame, but, within a very few minutes it picks up and the coal feed can be increased.

Up to this point the pulverised fuel has been burned with the primary stream only, and there has been a heating up of the regenerator, so that, with the increased coal feed, it is now possible to use some preheated secondary air. The flame rapidly improves, so that more coal can be burned and more preheated air used. Within the hour it is generally possible, depending on the size of the furnace, to have full load combustion and the furnace in continuous rotation. The heat units now being generated over the charge are reaching the maximum. Rotation of the furnace exposes fresh surfaces to the

heat, and the lining, superheated in the upper part of its travel, further assists in quick melting by giving up part of this to the metal as it travels underneath. As the furnace and charge come up in heat, and the secondary air increases in temperature, so the flame gets hotter due to the smaller temperature gradient between itself and the material with which it is coming in contact. This gives more rapid combustion, and the coal feed can be further slightly increased to give a greater heat release inside.

The simplicity of control and the instantaneous response to alteration of feed allows for such a high degree of control over the combustion that the furnace can always be worked at the optimum state for the conditions existing. If the metal is ready before the foundry is prepared to take it, coal feed can be shut down to half, or even off altogether, and again increased just prior to use. The same applies during tapping time depending on whether the metal is just sufficiently hot to run castings or superheated. When it is remembered how long metal will remain fluid in a ladle outside of any heated brickwork, except such as is communicated by the molten metal itself, it can easily be recognised it will remain fluid for a very long time without fuel in a closed-in type of retainer such as the rotary furnace with its superheated lining. The covering of molten slag acts as a blanket to prevent radiation, while its composition is such that it is inactive, and there is negligible alteration in the composition of the metal.

When using the furnace hot from a previous charge, it is possible to start off on a coal feed equivalent to 80 per cent. of maximum, which can be increased to full melting conditions with furnace rotation in from 20 to 30 min. This gives quicker melting times and less coal consumption. Flame control with little excess air allows for minimum oxidation while the time factor, which is of very considerable importance, in lessening oxidation, is reduced by the high temperatures possible. The quick melting of the rotary pulverised-fuel-fired furnace gives low oxidation losses of carbon, silicon, manganese and iron, so that in all they amount to about only 1 per cent. of the weight of metal charged. In addition to giving economies from the viewpoint of cost, there is the advantage of close control on chemical analysis of the product and greater certainty of working to specification.

The high temperature of the melt ensures fluidity and easy pouring of the castings for very thin sections and for difficult compositions of iron low in carbon, silicon, etc. Mild steel containing 0.16 per cent. carbon has been satisfactorily run into light castings, which gives an indication of the possibilities in the direction of fluidity. At the same time the temperature is under easy control and it can be kept down so as to produce satisfactory conditions where much lower-temperature iron is required for the foundry.

High Quality Iron.

The metallurgical advantages of the rotary-type furnaces are determined by the production of a high temperature, formation of a protective slag and rotation of the furnace. As just mentioned, it is possible to produce a true semi-steel or high-test cast iron as it is more commonly called to-day. By suitable mixtures of steel the carbon content can be reduced and controlled with a high degree of certainty. At the same time the extra temperature required for fluidity is readily obtainable.

For high-grade irons it is necessary to produce a very fine graphite structure with even distribution. It is now generally accepted that the principle to be aimed at to attain this end is to ensure that there are no graphite nuclei in the melt, and the minimum of non-metallic inclusions which might form nuclei. In order to dissolve all graphite carbon from the pig it is not only necessary to obtain a sufficiently high temperature but the time factor must also be considered. This varies with the nature of the iron and was overcome in cupola practice, etc., by using once-melted, refined or cold-blast irons, etc., which readily redissolve to a homogeneous melt at comparatively low times and temperatures.

In the cupola type furnace there was the further disadvantage that with high temperatures there was an additional solution of carbon from the coke giving supersaturated metal, unless precautions were taken to have a very rapid-melting rate. This supersaturated metal deposits graphite in the liquid state, which form nuclei, giving centres for growth. Fine-grained graphite is produced by preventing carbon separation until the liquidus is reached, by which time the carbon is coming out in a semi pasty mass, thus minimising mobility and ease of growth on nuclei already formed.

In order to reduce deposition in the liquid metal, carbon must be reasonably low, while separation in the solidifying range is largely controlled by the silicon content. The rotary type furnace is eminently suited to give the time and temperature to dissolve all graphite. The slag protects the metal from possible carbon pick up, so that low carbon iron can be produced which will not throw out graphite in the cooling liquid when cast, thus giving fine-grained material. The quantity thrown out is dependant principally on the silicon content, so it is possible to get similar analysis and similar shrinkage properties yet very much tougher iron owing to finer and better distribution of the non-metallic graphite. Rotary furnace practice is not so much a question of re-melting as the cupola. It is widely acknowledged that the material produced from a cupola is largely dependant on the properties possessed by the material charged to it. These so-called intrinsic properties have been the subject of much discussion, and the outcome has invariably been their complete vindication. It is probably not so much anything intrinsic to various brands which has given them superlative values for individual melting practice but rather the limitations of the furnace working. With the conditions obtainable in the rotary pulverised-fuel furnace, it is not merely a proposition to make a new shape from properties already existing but rather to form these properties from a mixture in which the fundamental conditions exist in an unformed state.

Another important feature of high-tensile irons is to produce a pearlitic structure and eliminate the softer free ferrite as much as possible. The most effective way to promote this type of structure is to aim for lower carbon and silicon with control of the cooling rate. The lower carbon gives less possibility of its deposition, while lower silicon increases the solubility of graphite with greater tendency to retain sufficient in solution as austenite to give its final deposition in the form of pearlite free from ferrite. The superheat of the rotary furnace gives fluid metal with the low carbon and silicon contents, while the dissipation of this high heat in the moulds permits of slower cooling rates which are also favourable to the formation of pearlite.

The well-known metallurgical advantages of a good slag may be briefly considered. In the cupola the slag covering the metal in the well is continually being disturbed by the falling column of charge and never gets an opportunity to work itself out to a neutral condition. In the open-hearth and rotary type, however, once the charge is down reactions take place along a definite line towards a point of equilibrium or neutrality. The iron oxide content is reduced with its consequent reduction in the metal also, thus giving deoxidised iron which is also degasified iron. Besides reducing metallic losses in the slag this gives much more important results in metal free from blowholes. The slag separates the metal from possible contamination by the fuel and the production of a low-iron slag high in lime assists sulphur removal.

Finally, the rotation of the furnace gives well-defined metallurgical advantages. It assists in the production of homogeneous metal throughout the charge and allows for quick incorporation of alloying or correcting additions. The rotation is slow, thus mixing the charge steadily and evenly, being assisted by convection currents off the bottom. Too violent agitation would tend to break the slag layer and produce absorption of gases. The movement also assists in disentangling minute particles of slag formed inside the metal and allowing them to rise to the surface where they become incorporated with the bulk of the slag. In this way castings are produced remarkably free from non-metallic inclusions.

Summary.

The principles of the operation of the rotary cylindrical furnace fired with pulverised coal have been discussed. The economic generation of heat from fine coal dust gives very high melting temperatures with consequent fluid metal for a wide range of cast-iron and steel compositions. Owing to the high temperature, formation of slag with separation of melt from fuel and rotation of the furnace very high-quality cast irons can be produced, giving toughness and high-tensile properties with freedom from inclusions and blowholes. The composition of the iron is under easy and accurate control.

Although the purely economic side has not been dealt with, it may be of interest to mention that all-in melting costs, including labour, depreciation, maintenance and materials compare very favourably with the cupola, so that in this type of furnace we have the much-longed-for ideal, better quality metal at a lower price for production.

Although the rotary pulveriser-fuel-fired furnace is still in its infancy, it has already proved itself a distinct asset in many foundries where it has been installed. As one who has been closely associated with its development, I have no hesitation in saying that it will find a very wide and successful application in the near future. It is not possible in the course of an hour's lecture to deal with the various aspects in anything approaching detail, so it is hoped that this indication of the essential principles and advantages may prove of interest. Owing to the specialised nature of each foundry, the problems arising are different. The large variety of interests represented here this evening has made it advisable to deal in general terms, but, nevertheless, we shall be pleased to deal to the best of our ability with particular questions which may be raised.

DISCUSSION.

The Chairman (Mr. W. Wallace) said that they had listened to an extraordinarily interesting Paper on a subject to which all connected with iron and steel foundries would require to give very careful thought. He, as an engineer owning a foundry, was wondering whether he would have to start work on Monday morning by going down to the foundry and ordering the scrapping of the cupolas. He hoped, however, that the practical men present and also the theoretical practical members, who, he felt sure, were anxious to discuss the Paper, would be able to give him some hope of avoiding the scrapping of cupolas for a time at least.

Mr. F. Hudson said the results obtained from the rotatory type of furnace were remarkable and marked a definite advance in foundry metal melting. He felt that the rotary furnaces definitely spelt the death of the cupola. There was one point which he would have liked Dr. MacNair to have dealt with rather more fully and that was in relation to the gases in the Brackelsberg furnace. He had not seen the Brackelsberg in operation, but he had seen the Sesci several times. What struck him was that the rotary type of furnace seemed to eliminate the necessity for composition control. To obtain from the cupola close-grained sound metal the composition

of the metal had to be controlled to very close limits, and for, say, cylinders, it was necessary to get a close-grained metal to keep the silicon under 1 per cent., but from the Sesci furnace he had seen metal containing 3 per cent. silicon which still had a close grain and practically free from shrinkage. There seemed something about the metal from these furnaces that made them apparently foolproof. He would very much like to have Dr. MacNair's explanation of this, as it seemed to him to be extremely important.

Slag Reactions.

Mr. D. Sharpe said that the lecture had been somewhat above him, as, although he had had experience of open-hearth steel, Tropenas and electric furnaces for manufacture of steel, he had had no experience of nor had he seen in operation the rotary pulverised-fuel-fired furnace. He had really attended in the hope of getting initiated into some of the tricks of the rotary furnace. Dr. MacNair had shown how closely could be controlled the composition and properties of the metal, and as an old steel melter he realised the importance of the slag in controlling the metal. He thought that the fact the metal was covered with slag and heated through it was very largely the reason of the remarkable increase of strength and properties of the metal even when starting with very poor-class material. He thought that the high results obtained with a very wide difference of composition was one of the biggest factors in the favour of the type of furnace from the engineer's point of view.

The Factor of Versatility.

Mr. A. Campion said that as one who had had the advantage of seeing both the Sesci and the Brackelsberg furnaces in operation he had been extremely interested in listening to the Paper. He was of the same opinion as Mr. Hudson in thinking that the rotary type of furnace was the most serious competitor to the cupola yet produced. It was a fact that a close-grained, strong iron was obtained from metal of a composition widely different from what one would produce from a cupola. He had not seen metal for cylinders with 3 per cent. silicon, but he had within the past few days seen a cylinder cast from the Brackelsberg furnace with metal containing over 2 per cent. silicon which had as high a tensile strength and a Brinell hardness equal to that of cupola-cast metal containing under 1 per cent. of silicon. The metal was cast hotter and much more easily than cupola metal. He was sorry that he could not say to the Chairman that his cupolas were quite safe, but he could offer him the consolation that if he installed a rotary furnace he would be in a position not only to cast iron but he would be able to produce steel castings in the same furnace at will. That, he thought, was a great advantage of the type of furnace—its flexibility.

The Brackelsberg differed from the Sesci inasmuch as it used fuel of a bituminous nature, and he would like to ask Dr. MacNair whether the percentage of volatile constituents effected the result in any way. He also wondered how the nature of the volatiles affected the combustion, he had in mind the Lanarkshire coals containing high-oxygen, high combined-water from which on heating the volatiles were expelled very quickly. This expulsion was of an endothermic nature, that was the reason they produced so much black smoke, and he would like to know whether the heat production in the rotary furnace was influenced in any way by this action. There was the question of the fineness of grinding of the fuel, theoretically, of course, the finer the grinding the more rapid the combustion, but from an economic point of view that was not correct. Dr. MacNair had stated the fineness as 75 per cent. to pass a 200-mesh sieve, but some time ago, in conversation with a pulverised-fuel expert, he was told that that was not an economic proposition and that 95 per cent. passing a 100-mesh sieve was the economic fineness. He would be very grateful if Dr. MacNair would give his views on that point.

Limited Application.

Mr. H. D. Campbell, Branch-President, said a number of points occurred to him that required consideration before one would adopt the Brackelsberg furnace. In the first place Dr. MacNair had not told them the cost of the installation and he would like to know that. In many foundries they were running metal and casting all day and he thought it would require a very costly outfit to keep metal running all day from a Brackelsberg installation. How would Dr. MacNair handle such a proposition? Then in the case of jobbing foundries requiring to cast at intervals large jobs, say, of 40 to 50 tons, it seemed to him that it would be a costly business holding the metal in condition until a sufficient quantity was gathered. Every foundry was a different proposition and he thought that in many cases successful working would demand batteries of Brackelsberg furnaces to keep them going and that would mean a heavy capital outlay and running costs. He would like to ask Dr. MacNair what was the cost of lining a furnace and the cost of lining repairs and furnace maintenance as compared with the cupola. In his own foundry they had cupolas which were rammed with "silacene" six years ago and to which nothing had been done except ordinary patching. He would like to know the life of the Brackelsberg lining. He also thought the moving parts, gears, etc., and the seven motors attached to the furnace would cost a considerable sum in maintenance. He had greatly enjoyed the lecture and they were indebted to Dr. MacNair for coming to Edinburgh and addressing them. He had given everyone something to think about.

A Steel-Melting Unit.

Mr. J. Currie said that the author had put forward the Brackelsberg furnace primarily for the production of cast iron and had mentioned it could be adapted for making steel. Could Dr. MacNair bring forward the furnace as an economic proposition for the manufacture of steel castings? If so, would he indicate where the economy was obtained? Was it from the raw materials or the melting process? The Brackelsberg offered an interesting proposition affecting the users of the stock converter, as they generally had heads and risers to get rid of. Could the Brackelsberg take these, and what was the limit of size that Dr. MacNair recommended to be charged.

A Member asked if it was possible when making steel in the Brackelsberg furnace to reduce the sulphur and phosphorus and what sort of lining Dr. MacNair would recommend. Should the lining be rammed with dolomite completely or lined with bricks?

Author's Reply.

Dr. MacNair, in replying, said that he thanked them for the discussion. Mr. Hudson had raised the question of composition, and suggested control of it was unnecessary. The idea of not needing composition-control was fairly simple. In cupola melting, where two or three different mixtures were required to be charged each day, it was not done because the foundryman wanted to, but because of the limitations of the cupola. For the production of cylinders, the iron it was necessary to charge into the cupola was expensive and must be within close limits of composition to obtain the desired results. It was not an economical proposition to use that metal for other castings. If it were not for the limitations of the cupola, cheaper metal might be charged. The founder did not require such close-grained strong metal for, say, firebars, so he utilised his rubbish there. The result in the rotary furnace was to make an all-round better type of iron from cheaper materials. It did not matter what they put in the Brackelsberg furnace they poured out good metal. Even if they did produce metal with 3 per cent. silicon they had an even grained metal with fine graphite, perhaps they had rather less pearlite but the fine graphite made all the difference. Because they reached such a high temperature in the Brackelsberg furnace they had all the carbon in solution which separated into pearlite and very finely-divided graphite. They produced a full pearlitic structure free from gas and blowholes. They always got a good water test on account of the fine even structure. It all came back to the idea of intrinsic properties of pig-iron, which was really due to the limitations of the cupola process. He was glad that Mr. Sharpe had appreciated the value of the slag in controlling the properties. As an old steel worker he would, of course, appreciate that point, he himself in his young days had worked at steel and appreciated the action of the slag. They could not control the slag in a cupola.

He thanked Mr. Campion for his remarks, and, as he had said, the Brackelsberg was a very elastic furnace. It could be used for cast-iron high-grade firebars, steel and malleable iron, etc., in succession. The idea to-day was a unit in every foundry where the demand was at so low an ebb. What was not economic in the cupola would be in the Brackelsberg furnace. He did not think the price of the fuel was of very much importance. He was glad Mr. Campion had mentioned the rapid combustion of the volatiles, as it was a matter of extreme importance. He had some figures showing how the volatiles came off with a terrific burst, and 60 per cent. of the volatiles were burnt in 0.05 sec. and 100 per cent. in 0.2 sec. The fixed carbon burnt slower, about 97 to 98 per cent. in 0.5 sec. Dr. MacNair here drew graphs on the board showing the rates of combustion, etc. The Sesci furnace used anthracite coal, but the combustion was therefore slower. The combustion of the little particles of pulverised fuel was quite different from the combustion of fuel in a grate. He thought the use of anthracite was wrong. With anthracite there was, say, only 0.5 per cent. volatiles to come off, whilst with bituminous coal there was 30 per cent. to be evolved, and did so with a burst, thereby splitting them up into still smaller particles, making the rate of combustion extremely rapid. After that the combustion of the fixed carbon was very slow. What was the best degree of fineness of the fuel was a matter at present under discussion. Theoretically the best fineness was one that gave complete combustion in 0.22 sec. or to give a release of 100,000 B.T.U. per cub. ft. per hr. They stipulated a fineness of 75 per cent. through a 200 mesh, but with anthracite 90 per cent. was required. They had, however, worked with a lower fineness than 75 per cent., and had even used 55 per cent. through 200 mesh. The fineness necessary was not as great as some people thought.

Re-Melting Headers.

Mr. Currie had asked if the furnace was an economic proposition for steel. It was cheaper than the crucible Stock converter and also in regard to the Tropenas if they worked out the cost of melting in cupolas and the loss of 15 per cent. against the Brackelsberg 1 per cent. That gave them the first economy, and secondly the coke used in the cupola was often very excessive. They had to add to the cupola coke the blast charges for the converter, and, comparing these, the Brackelsberg was very economic. In regard to Mr. Campbell's question of the lining, they used half a hundredweight per ton of metal melted. In regard to the maximum size of material used in a 5-ton furnace, he would say a head of 5 cwt.

Mr. Currie: It would be more like 2 tons that they would require to charge.

Dr. MacNair: Then in that case the life of the lining would be 50 or 55 charges. For cast iron to-day, 150 charges was the life of the

(*Concluded on page 292.*)

Institute of British Foundrymen.

WEST YORKSHIRE BRANCH.

The new session of the West Yorkshire Branch of the Institute of British Foundrymen was opened on October 8 at the Bradford Technical College. Mr. A. S. Worcester (Huddersfield) gave his presidential address. During the period of the presidential address the chair was occupied by Mr. R. D. Welford (Bradford), Senior Vice-President.

Presidential Address.

In the course of his remarks, MR. WORCESTER said that at the commencement of the last session he was optimistic regarding the immediate future of the industry. Unfortunately, his optimism was unjustified, and later events were giving even less cause for satisfaction. He did not propose, therefore, to assume the mantle of the prophet on this occasion. Thus, founding had degenerated into a scramble for solvency rather than an instrument of profit production. The West Riding of Yorkshire was perhaps suffering more acutely than many, largely because of the prevalence there of jobbing foundries. The present depressing conditions was reflected in the sad plight of many foundry craftsmen, some of whom were leaving the industry for other ventures. Numerous old establishments which had stood as landmarks for generations had been forced out of business, and the majority of those which were left are experiencing great difficulty in keeping their doors open.

In spite of this catalogue of industrial ills, founders in general had not allowed the existing conditions to obscure the possibilities of a revival, and many—the wise and the fortunate—were making drastic efforts to reconstruct their businesses upon more scientific and economic lines.

The healthy state of the Institute was a particularly bright feature, denoting as it did an eagerness on the part of founders to procure the latest information and a desire to keep in touch with modern developments. Certainly, a great deal of information and science had been incorporated in the production of the castings which were on the market to-day. Not only were they better in quality than ever before, but they possessed the advantage of cheapness—a factor which had been engendered by scientific methods of manufacture. Therefore, it may be justified, when reviewing the affairs of the Institute and of the West Yorkshire Branch in particular, in taking some pride and pleasure in the progress which had been achieved under such trying conditions.

Appealing for a maintenance, and even improvement, on last session's excellent attendance record in the West Yorkshire Branch, Mr. Worcester said it was only by their own co-operation that the industry and they themselves could enjoy the fruits of the great and voluntary labour which was being constantly put in on behalf of the trade, both nationally and internationally. Striking proof of this—if any proof were needed—was forthcoming in the records of the Technical Committee of the Institute; a committee of men who, themselves by no means persons of leisure, had entered thoroughly into the business of research for the general good and who expended valuable time in the effort to place basic facts before the industry. As an ordinary member of that Committee himself, Mr. Worcester apologised for any seeming eulogy of its work, but said he wanted to impress on the operatives the sacrifices which were being made by some of the leading industrialists on behalf of all grades of foundrymen. During the past session, the Committee had been unfortunate in losing the services of Mr. Jolley, who had resigned after a lifetime of service to the industry; but in Mr. Gardom they had an able and enthusiastic successor, and one who had risen to the occasion in splendid manner. An extensive survey work was being done, and, when published, would be found to be invaluable to the Institute and its members. Evidences of the "live" forces behind this Committee, said the President, were shown by the Malleable Iron Section's contribution at the Annual Convention.

Education.

Turning to general matters, Mr. Worcester said the inauguration of the Craft Certificates scheme under the auspices of the City and Guilds of London Institute had met with a fair measure of success, but the number of students attending the courses could not yet be considered adequate, and a wider effort must be made during the coming year to get more of the apprentices and young craftsmen in each centre to attend. At the Huddersfield centre they had managed to get 32 to attend, and he urged all members to help in encouraging the boys and young men to take up the courses.

Foundry Equipment.

In a cursory survey of the past year's work and events in the foundry trade, Mr. Worcester thought nothing startling stood out, but steady progress was being made, and, taken on the whole, their own branch of the industry was able to cater for practically all demands, and in many instances was doing pioneer work in offering lighter, stronger and often cheaper metals to the engineer. The foundry-equipment trade seems able to give everything necessary, and to offer assistance in helping to get the best tool for each job. The same with materials—expert advice could often be obtained to get the best out of them. There was also a desire to give what was required, and often within fine limits.

Referring to the personnel of the foundry, Mr. Worcester was not happy about the situation. Good craftsmen were scarce, and he reiterated the hope of last year, that the Technical Committee would solve the problem, assisted by the Institute generally. In conclusion, he said he was convinced that the tools, material and brilliant men in the foundry trade were available. These factors could achieve bigger things than ever in the past, and the best and probably the only way to get them to function with complete success was through the interchange of ideas and comparison of results and experiences at Institute meetings and works visits.

Vote of Thanks.

MR. W. G. THORNTON (Bradford), Past-President of the Branch, in proposing a vote of thanks to Mr. Worcester, said he felt he could endorse every word the President had uttered in reference to conditions in the foundry trade during the past year, and the immediate prospects so far as they could be judged.

MR. F. K. NEATH (Keighley), in seconding the vote of thanks, said the fact of the matter was that everything had to be viewed to-day from a standpoint vastly changed from that of some years ago.

THE FEEDING OF CASTINGS.

MR. S. W. WISE, hon. secretary of the Branch, said "feeding" was a matter which foundrymen had before them every day, yet it remained a matter of wide divergencies of opinion as to whether it was really essential that castings must be fed. He felt, however, that the essence of the subject was method, and his own experience suggested that as a general practice the only effective and satisfactory way was to feed with a portion of the casting attached, in the shape of a feeding head. Personally, he felt that feeding rods were of little real value in making a casting safe, and that the adoption of the rod policy was liable to do more harm than good. Where he had experienced feeding by rod, he had much more waste than was his experience after abolishing that practice. Founders were not always sure just why they fed. Take the case of a casting commonly examined when people were discussing foundry methods—a coupling. General opinion was that if a coupling was a waster it was solely because of shrinkage of the metal. It was usually bad about one-third of the distance down. To his mind there was nothing in the section as a rule to account for this from the point of view of shrinkage That mischief was more often caused by the first metal going into the mould, which cooled more or less rapidly according to the area of the mould that it covered, and was carried in a semi-plastic state towards the top of the mould with the flow of metal until it found something to arrest it; here it set more rapidly than the remainder of the metal, which it turn shrunk away from it. If that was so, it suggested two methods of treatment—either to run the metal in as rapidly as possible in order to reduce this sudden cooling as much as possible, or else to run slowly to get as near simultaneous solidification as possible.

Ordinary Cylindrical Ring.—If such a casting were large it would often be found that the porous patch again about one-third of the way down was present. What was there in such a ring—speaking from the point of view of shape and structure—to cause any segregation? It was of equal section—had equal walls; and yet it would probably be agreed that it was rarely sound throughout its length.

Motor Pistons.—If there were any difficulty with the production of these castings it was usually due to porosity in the gudgeon-pin boss; and more often than not it had occurred in one boss only. He thought the same thing applied—the partially-solidified metal, floating on the top, was trapped in the first boss it reached and the hotter metal shrunk away from it.

Gear Blanks.—The porosity in this case was usually at the end of the arms, because there was no reason except the reason indicated. The porosity was here found at right angles to the web of the arms. One could suggest many other types of castings to which the same phenomenon applied, and he suggested that if it were possible to run sufficiently fast to fill the mould instantaneously it would go a long way towards the elimination of porosity in castings.

MR. G. NEILD said he was in entire agreement with Mr. Wise in what he had to say about feeding rods, and believed there was more wastage due to rod feeding than the contrary. He agreed that the great need was a high-temperature metal of sufficient volume.

Rod Feeding Condemned.

MR. W. PARKER (Halifax), Past-President of the Branch, said he also was of the same opinion as Mr. Wise. The only satisfactory way he had found, when making couplings and rings, was quick running in the bottom, and they should be made a little wide at the top, like a small head. One should put on a head with plenty of taper, cast it rather hot and immediately it was cast slowly teem at the runner and force it through. It was inadvisable to add any extra metal. Immediately the metal appeared in the riser, one must stop pouring and fill slowly. In casting with a quantity of cores in a boss, say, about 1 ft. long and 9 in. dia., he had found casting with risers and putting on pressure met with success. One could not feed by rod successfully unless one was able to control the operation continuously.

MR. H. SAYERS (Leeds), Past-President, said he presumed the point at issue was as to whether

rod feeding was helpful, rather than whether any feeding at all was any good. He endorsed Mr. Wise's premises, though not entirely his logic. Bad spots were in every case the last to solidify.

Mr. Wise, replying to the previous speakers, said, in answer to Mr. Sayers, he was not insisting that feeding was useless. He agreed that a casting must be fed somehow, and it was entirely a question of how. He agreed with Mr. Parker's remarks. In his own experience he had had similar trouble to that mentioned by Mr. Parker, and what he did was to feed through a narrow neck. He (Mr. Wise) did not believe in the taper feeder. It was, of course, a mistake to keep a head on until cool, or one would get a coarse grain in its immediate neighbourhood.

Mr. Parker, referring to rings, said with those of small diameter, the question was that of getting them clean, if not actually sound, say about ¾ in. thick as-cast, to be machined down to ½ in.

Mr. Wise said the same thing applied. There was one way to get that type of casting clean, and that was to run it with a number of small runners straight from the top.

Mr. Parker said he had had as many as 40 runners round the bottom and 40 round the top alternatively, to give both methods a fair trial, and still suffered from spalling.

Mr. Wise replied that, in dealing with a similar type of casting, he found it a good practice to form a well in the top part, which served the purpose of a bush and from which three small equidistant runners were taken round the top flange.

Mr. Parker said he had also tried that way, but he found when about 36 in. was reached one could run them fast enough to get them clean. Eventually he had a man with a rod to stir the metal and cast the moulds open and thus managed to get the castings clean.

Mr. Wise replied that in his experience he had had very little difficulty from dirt; the only real trouble in the larger rings was porosity.

Mr. H. Forrest (Bradford) asked whether the piston boss was run in the bottom, up the runner or at the opposite side to it.

Mr. Wise said he had cast them with a runner all round the top; and he had run them with one boss and simultaneously with both bosses. He had run them with horn gate underneath, and also with a runner all round the bottom—and all gave exactly the same effect.

Mr. Forrest said he had the same difficulty and had introduced a taper chill and that cured it. Perhaps the composition of the metal had an important effect. Mr. Wise mentioned the colder metal rising on the surface. From experience in steel founding—and the problems were very much akin to those of iron founding—he would endorse the opinion. One could see the cold metal rising on the top and one saw any dirt that was rising with it wash along and rise against the sides of the mould. The same thing happened with steel as with cast iron, but steel showed it up more clearly. In regard to the matter of the gear-blank rims, it had been found desirable to increase the outside diameter by sloping it off at the top and cut off about one-third as riser. In regard to the taper riser, or the narrow-neck riser, he had tried them in steel practice, but he had not found the riser as illustrated by Mr. Wise on the blackboard to work satisfactorily, and found it more effective to invert it.

Mr. S. Carter (Huddersfield) asked was it not somewhat "far-fetched" to suggest that a 6-ft. ram cast from the top would have a stiff metal at the top of the casting at the finish.

Mr. Wise replied that he had referred to smaller castings which if run slowly created a tendency for the metal on the bottom to set and that rose with the more fluid metal. With a ram the point was that one went to the other extreme and built it up gradually with a slow runner when one could wash it away quickly.

Mr. Sayers remarked that one of the causes of porous spots and holes in castings was the yielding of the mould.

Mr. Wise said that it could occur by retarding the internal shrinkage. That was one feature of a special proprietary process, because in that process they utilised dry moulds.

Mr. Forrest said he thought it was a question of providing sufficient liquid metal to fill up the shrinkage. If a riser were used it must be at the last point to solidify. With a rim he would put it at the junction of each arm.

In answer to Mr. Neath—who remarked that Mr. Wise had not mentioned the matter of casting temperatures in his observations—Mr. Wise said he had avoided the question of temperature entirely because it depended on the nature of the thing being cast, and he did not think they would attempt to enunciate any hard and fast rule as to temperature for that reason.

Rod Feeding Sometimes Essential.

Mr. J. H. Wright (Leeds) spoke of trouble he had had with a rim gear which had three lugs, set in a recess about half an inch from the casting. The difficulty was in getting the teeth clean. The difficulty went on so long that the job was eventually given elsewhere, but the new firm encountered the same difficulty of the black spot when cutting the teeth. The buyers insisted that they had had these products perfect previously and demanded that they must be perfect again. Eventually, said Mr. Wright, the problem was solved by making them in dry sand and carrying the boss to the top instead of having them recessed. He had come to the conclusion that a casting of a round character was not perfect on the outside, and that it was an impossibility to get a perfect casting that was round, whatever form it be, if it has any arms. At the point where solidification started setting in he believed it must be porous because when it contracted something must go somewhere. In the matter of feeding, proceeded Mr. Wright, he recollected an experience with a printing-machine cylinder with trunnions on at the top. These were cast with chills on the top and ordinary dry sand at the bottom. In the machine shop one of the trunnions was accidentally broken and it was found to be very porous where it joined to the body. The firm had never fed them before and they now started to feed. They broke it up to see if it was solid. The feeding experience in this matter proved conclusively to him (Mr. Wright) that, for anything heavy, rod feeding, intelligently used, was necessary.

Mr. Wise said he never insisted that the rod feeding would not make a good casting, but he did suggest it would make more bad ones than good. He fully realised, of course, that there was a difficulty in getting printing-machine cylinders sound at the arm ends. In his personal experience of that type of production he fed them, but he was certainly not free from trouble.

Efficiency of Flat Gates.

Mr. L. Farrar (Shipley) said he had run cylinders with flat gates all round the top, alongside the body-core, and that was a decided advantage. Any dirt that entered was taken up by that method of running and the dirt that entered a runner—say, 1 in. wide and ¼ in. thick, in a cylinder with a 2-ft. bore—was very small indeed. To his mind there was a distinct advantage in running a mould from the top. He had never had difficulty with couplings, running them with small runners from the top and a pear-shaped riser upside down so that there was no "stalk" on the casting; the riser was part of the casting itself, and was quite easily knocked off. Instead of feeding, one should keep on slightly dribbling the metal through. Mr. Farrar asked if anybody present had had any experience of pouring water on top of the risers. He had seen it done with success.

Mr. Wright said he had choked castings with water. There was a limit in feeding metals, and when he saw that that limit was reached he choked with water.

Mr. G. Hall, a member of the London Branch, lately come to Shipley and present at the meeting by invitation, said he had been greatly interested in the discussion, and had noticed that nothing had been said as to what irons they were to incorporate. Were they going to take just the iron that was given them and hope to get a good casting, or was it better to seek an iron of the most suitable composition for the purpose in view? Mr. Hall said he had spent about six years working in a special process, and he felt certain that any of the products under consideration that evening would have been sound when utilising that process. He had himself made hundreds of these things sound by that process and never more than a 4-in. riser to any depth.

Mr. Wise said he had refrained from discussing metal compositions deliberately, because it was a matter that would widen the scope of the discussion too much and perhaps go far beyond what was intended within the space of a single evening.

Nickel Iron.

Mr. W. Fearnsides (Shipley) asked if any members had had much experience in adding nickel when casting irons.

Mr. Wright said he had used it very successfully. In using nickel, one should ascertain the proportionate weight and let the metal teem on to it, and it would be successful. When he cast with nickel, added Mr. Wright, he did not usually cast at the same temperature as without that addition.

Mr. Neath said nickel had a cleansing action on the metal, but he hardly thought it had any serious effect on the shrinkage.

Mr. A. W. Walker (Huddersfield) said casting with nickel demanded special treatment, or there may be bad results. Nickel seemed to behave satisfactorily in large castings, but in the thinner castings his own experience was that it was not so successful.

The President, winding up the discussion, said he thought they had proved to general satisfaction, at any rate, that rod feeding could not be eliminated entirely, so long as it was judiciously used. The great thing was to get the metal into the mould and keep it at an equal temperature. Another point usefully emphasised was that a quantity of dirt was liable to gather at the sides in a cold mould, and that had to be avoided.

The thanks of the meeting were awarded Mr. Wise, on the motion of Mr. Parker, seconded by Mr. Sayers.

British Gas Engineers to Visit Canada and U.S.A.

It was stated at the Autumn Research Meeting of the Institution of Gas Engineers in London last week that a party of gas engineers and other members of the British gas industry will visit Canada and the United States next September. The party will visit Quebec and Montreal, and then attend the Canadian Gas Convention at Ottawa, after which they will go on to Toronto, Niagara Falls, Detroit and Chicago. The American Gas Association will be holding its Convention at Chicago, and the visitors will also tour the Chicago Centennial Exhibition, "A Century of Progress," where there will be a special "Old Europe" section showing corners of typical European towns. The British gas industry is paying particular attention to-day to the development of gas for industrial processes. They hope, therefore, to gain useful information from the Chicago Exhibition, where the most up-to-date industrial processes used by American manufacturers will be shown. The British delegation will also take special interest in the industrial developments in Cleveland, Pittsburg and Philadelphia, which—together with Washington, New York and Boston—are amongst the remaining cities to be visited during the course of the five weeks' tour.

This Week's News in Brief.

Trade Talk.

Mr. C. H. Murrell, The Abbey Foundry, Harrow Manor Way, Abbey Wood, Kent, ironfounder, has been adjudicated bankrupt.

The Leeds branch of Messrs. W. T. Henley's Telegraph Works Company, Limited, has been transferred from 95, Albion Street to 1, York Place, Leeds.

The new French liner "Normandie," launched at Saint Nazaire on Saturday, October 29, is the world's largest ship. She is more than 1,000 ft. long, and is larger by nearly 20,000 tons gross than the biggest vessel in service. Her engines employ the turbo-electric drive.

Messrs. Brookhirst Switchgear, Limited, Chester, have received an order from the Cardiff Corporation Electricity Department for nine of their new E.H.T. oil-pressure breakers. The contract covers three 250-amp., three 350-amp., one 750-amp. and two 1,500-amp. breakers, all 6,600 volts.

An extraordinary general meeting of the shareholders of the British Oxygen Company, Limited, was held in London on October 27 to approve a conditional agreement entered into by the company with Metal Industries, Limited, and Oxygen Industries, Limited. The proposals submitted to the meeting were approved.

Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, announce that they have put into production at Scotswood, Newcastle, a wide range of large and small oil-electric shunting locomotives designed to meet the requirements of industrial firms as well as the railways. The locomotives can be driven by one man, the control handles being duplicated on either side of the driving cab.

The shareholders of Messrs. Tweedales & Smalley, Limited, textile machinery makers, of Rochdale, have defeated by a vote of 413,477 shares to 259,636 shares an offer for the sale of their concern to Textile Machinery Makers, Limited, the combine of Lancashire textile engineering firms which was formed a year ago. The directors were divided on the matter and made no recommendation to the shareholders.

A contract for a first-class turbine steamer specially designed for passenger service on the Clyde has been placed with Messrs. William Denny Bros., Limited, Dumbarton, by Messrs. Williamson-Buchanan Steamers, Limited, Glasgow. The general design of the vessel will be similar to that of the "King George V" and the "Queen Alexandra," both of which were built by Messrs. Denny, and will be propelled by triple screws and high-pressure turbines. Work will start immediately, as the ship is to be ready for next summer.

Messrs. Harland & Wolff, Limited, have secured an order for a twin-screw cargo and passenger vessel for the Bombay Steam Navigation Company, Limited, Bombay. The hull of the vessel will be built on the Clyde at Govan, and the machinery constructed at Belfast. The vessel will be 200 ft. in length, propelled by two sets of triple-expansion engines and one double-ended boiler designed for either coal or oil firing. The boat will be built to meet the requirements of Lloyds and the rules of the Indian Government.

Orders placed in this country by Russian trade organisations during the past two months include the following (according to the monthly review of the Moscow Narodny Bank, Limited) in addition to those reported in our last issue:—Steel boiler plates (£50,000), United Steel Companies, Limited, Sheffield; steel boiler plates (£50,000), British (Guest Keen Baldwins) Iron & Steel Company, Limited, Cardiff; steel tubes (£18,000), Accles & Pollock, Oldbury; drill sharpeners, etc., Climax Rock Drill Engineering Works, Carn Brea, Cornwall; 26 locomotives, Beyer, Peacock & Company, Limited.

Messrs. Beardmore & Company, Parkhead, Glasgow, are demonstrating their new motor engine, which runs on crude oil instead of petrol, at the Scottish Motor Show, which opens in Glasgow on November 11. Production of the engine has already started at Parkhead, and the firm are hopeful of securing at the show sufficient orders to keep a large number of men steadily employed for some time. Omnibuses fitted with this engine are already being run by a Falkirk company, Glasgow Corporation and in Hull, with reported satisfactory results. It is claimed that the new engine decreases running costs. Crude oil for the engine costs only about one-third of the price of petrol, though the initial cost of the unit is greater than that of the ordinary petrol engine.

The single-screw 2,800-passenger and cargo vessel "Hunan," built for the China Navigation Company, Limited, London, was launched by Messrs. Scotts Shipbuilding & Engineering Company, Limited, Greenock. This launch marked a long connection between builders and owners, as it is the eightieth constructed by Messrs. Scotts for the owners since 1876. The vessel is 298 ft. long between perpendiculars, moulded breadth 44 ft., and moulded depth 25 ft. The main engines are of the triple-expansion reciprocating type, the cylinders being of special construction designed to reduce heat and pressure losses to a minimum. The pistons are 20, 33 and 53 in. dia. respectively, with a common stroke of 39 in. Steam is supplied by two cylindrical boilers fitted with forced draft and a full installation of auxiliary machinery is provided.

Contracts Open.

Cholsey, November 18.—(1) 674 yds. of 3-in. cast-iron water main, and (2) pumping plant, for the Wallingford Rural District Council. Messrs. Fiddian & Deeley, 13, Church Street, Stourbridge. (Fee £1 1s., returnable.)

Dublin, November 17.—Iron and steel stores, for the Great Northern Railway (Ireland). Mr. F. C. Wallace, secretary, Amiens Street Station, Dublin.

Dublin, November 23.—Iron and steel stores, for the Great Southern Railways Company. Mr. H. S. Coe, secretary, Kingsbridge Station, Dublin.

Dublin, November 14.—Two power-driven pumps, for the Corporation. The City Engineer's Office, 28, Castle Street.

Grafton, N.S.W., December 19.—Water turbine driven 6,600-volt generating set of 1,000 k.v.a., for the Clarence River County Council. The Department of Overseas Trade. (Reference A.X. 11,561.)

London, S.W., November 18.—Overhead electric travelling cranes, for the Fulham Borough Council. Messrs. Preece, Cardew & Rider, 8, Queen Anne's Gate, Westminster, S.W.1. (Fee £5, returnable.)

Seaford, November 26.—Automatic electric centrifugal pump, etc., for the Urban District Council. The Surveyor, Council Offices, Seaford, Sussex.

Obituary.

Mr. John Eynon, of Newcastle, inventor of the stockless ship's anchor, died recently at the age of 85.

Mr. John Ford, founder of the firm of John Ford & Sons, Limited, metal merchants, Burt Street, Cardiff, died on October 21. He was 88 years of age.

Mr. William S. Hide died at Hull recently, aged 71. He was managing director of Earle's Shipbuilding & Engineering Company, Limited, and for many years was president of the Hull Iron Trades Association.

Recent Wills.

Barrow, L. N., a director of the Staveley Coal & Iron Company, Limited ...	£28,461
Short, Andrew, of Enfield, formerly of Tynemouth, late director and works manager of the Cookson Lead & Antimony Company, Limited, North Shields	£11,946

British Cast Iron Research Association. — The October issue of this Association's Bulletin contains in addition to the usual features Papers on "The Strength of Coal Iron in relation to Combined-Carbon Content," by J. G. Pearce, and "Fatigue Tests on Cast Iron," by Prof. C. H. Bulleid.

Personal.

Mr. Harry Winterton, a Past-President of the Scottish Branch, Institute of British Foundrymen, has been re-elected to the Town Council of Milngavie, Dumbartonshire.

Mr. J. McLure Renwick has been appointed director of the Universal System of Machine Moulding and Machinery Company, Limited, of 13, Wilson Street, Finsbury, London, E.C.2.

Mr. D. Spittall, a departmental manager at the Frodingham Iron and Steel Works, has left Scunthorpe to take up an appointment as works manager at the Earl of Dudley's Round Oak Works, Brierley Hill.

Mr. James Galt, senior partner in the firm of Henry & Galt, Sneddon Foundry, Paisley, and one of the original members of the Scottish Branch of the Institute of British Foundrymen, has been elected Provost of Paisley.

Mr. David D. McGuffie, late manager, the London Foundry Company, Limited, Brimsdown, and foundry manager at the Aceros S.A., Lasarte, Spain, has been appointed by James Evans & Company, Limited, Blackfriars, Manchester, as their representative for the London district for the sale of foundry equipment.

Mr. William Morgan, who retired recently after serving for 50 years as analytical chemist to the Tredegar Iron & Coal Company, Limited, has been the recipient of presentations from his colleagues. The presentations were made by Mr. W. D. Woolley, J.P. (managing director), and Mr. D. Evans, J.P. (general colliery manager).

Mr. A. Guthrie has been appointed as Scottish representative for the Fordath Engineering Company, Limited, the manufacturers of the well-known "Glyso" core compounds, etc. This appointment, coupled with the fact that some of this company's technical representatives will periodically visit Scotland, will ensure for their clients, both actual and potential, the full benefits of the service department of the Fordath Engineering Company, Limited.

Mr. James Russel, who for over 30 years has been works manager at the Grange Foundry of Messrs. Grangemouth Iron Company, Limited, Falkirk, has just retired owing to failing health. When Mr. Russel took up his position in 1902, the Grange foundry employed only some 50 men, and the works covered about half an acre. Under his careful and enthusiastic management the foundry has progressed until at the present time it normally gives employment to over 500 men, and the works cover 3½ acres. Mr. Russel was a man of strong and outstanding personality of the old sturdy Scots type, holding independent views and having as their hobby only their job, and whose motto could well be "mak siccar." Before joining the staff at Grange Foundry, Mr. Russel was for many years a moulder in Abbots Foundry Company, Limited, and the Grahamston Iron Company, Limited, Falkirk, and for some years was moulding-shop foreman in Messrs. Cockburn's Gowanbank Foundry, Falkirk. Mr. Russel was of a retiring nature, and disliked publicity, so that it was not surprising that he should wish that no function of any kind should mark his departure from the works. The managing director and foremen presented to him privately a silver cigar and cigarette cabinet, suitably inscribed, as a token of appreciation of his services to the firm and the esteem in which he was held by the staff.

Company Reports.

Stanton Ironworks Company, Limited.—Interim dividend of 4 per cent., less tax.

Glenfield & Kennedy, Limited.—Interim dividend on the ordinary shares of 2 per cent., less tax.

British Oxygen Company, Limited.—Interim dividend for 1932 on the ordinary shares of 2 per cent.

Sir William Arrol & Company, Limited.—Dividend on the preference shares for the half-year to June 30, 1932.

Renold & Coventry Chain Company, Limited.—Interim dividend on the ordinary shares of 2½ per cent., less tax.

W. T. Henley's Telegraph Works Company, Limited.—Interim dividend on the ordinary shares of 7½ per cent.

Samuel Osborn & Company, Limited.—Profit, £13,100; brought in, £10,069; preference dividends, £14,366; carried forward, £8,804.

XUM

Raw Material Markets.

Although progress is still slow, there is undoubtedly an upward movement in the iron and steel markets, aided by the more permanent protection granted to the home industry and the rise in gold prices for export on the Continent. Little Continental competition is now being experienced in the home market. Business in pig-iron remains restricted, consumers still being disinclined to enter into forward contracts. Orders for steel remain disappointing. Prospects in the tinplate and galvanised-sheet trades are improved, especially so as a result of the Ottawa agreements.

Pig-Iron.

MIDDLESBROUGH.—Owing to increased activity at the steelworks, the latter are taking an increased proportion of the local pig-iron output. The export market has also opened out somewhat, several good orders having been booked recently. The local market, however, does not give so much encouragement, foundries making much use of the very cheap supplies of scrap still available. The fixed prices for Cleveland iron are:—No. 1 foundry, 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s. per ton.

There continues to be a fair demand for East Coast hematite. One furnace on hematite has been blown out at the Skinningrove works, but two more are being put into blast at Normanby, and it is questionable whether the extra output can be disposed of without further depressing the market. Mixed numbers are quoted at 59s. and No. 1 quality at 59s. 6d., but these figures might be shaded for prompt payment. The West Coast hematite market remains steady, there being no alteration in Bessemer mixed numbers at 66s. per ton.

LANCASHIRE.—One or two forward contracts extending over the end of the year have been booked, but the majority of consumers are still working on a strictly hand-to-mouth basis, owing to the continued slowness in the local foundry industry. In the aggregate, deliveries into consumption are about maintained. For delivery to users in the Manchester district, Staffordshire, Derbyshire and Cleveland brands of No. 3 are all available at 67s. per ton, with Northants at 65s. 6d., Derbyshire forge at 62s., Scottish foundry at about 83s. 6d. and West Coast hematite at 81s. per ton.

MIDLANDS.—Any demands for pig-iron come mostly from the light-castings foundries, conditions in the general and heavy engineering industries in this area remaining very slow. Several forward contracts have been arranged since the recent re-affirmation of prices by the makers, but the general run of business is on the small side. Prices are maintained at 62s. 6d. for Northants No. 3 and 66s. for North Staffordshire, Derbyshire and Lincolnshire No. 3, delivered Birmingham and Black Country stations.

SCOTLAND.—New business remains very restricted, owing to the lean state of consumers' own order-books. Official prices remain at 67s. 6d. for No. 3 foundry, with 2s. 6d. minimum extra for No. 1 quality. No. 3 Middlesbrough is at 55s. per ton f.o.t. Falkirk, with Midlands brands at 54s.

Coke.

There is no change to report in the position of the coke market, conditions remaining dull in accordance with the state of the iron and steel industries. Best Durham foundry coke is available at Birmingham at 36s. 9d. to 38s., with other grades at from 34s. to 35s. Welsh coke varies from 30s. to 45s., according to analysis, delivered in the Birmingham area.

Steel.

Market conditions have now become adjusted to the fall in the exchange, and business has been transacted with greater confidence. In the export markets also the depreciation in the exchange has brought business to the British works. Owing to the advance in prices, the effects of the duties and the fall in sterling, there has been very little buying of any description of Continental steel for the home market, but there has been a fair amount of export business transacted, particularly with the Far East. The demand for British steel appears to be expanding, and in some cases prices have been advanced from the low levels which have been ruling. In the semi-finished steel department the demand has been on the quiet side, and Continental competition has practically ceased. Most consumers continue to buy on hand-to-mouth lines, but the volume of business appears to be increasing. Transactions in finished steel also have shown some improvement and some of the recent export inquiry has developed into business, although the tonnages involved have been comparatively small.

Scrap.

Conditions remain largely stationary in the scrap-iron markets in the North of England and Scotland, the foundries being well stocked and their consumption limited. In the Midlands, however, there is increased activity at the foundries, and more cast-iron scrap is being used, particularly light metal. Heavy machinery metal is offered at 42s. 6d. to 45s., and clean light cast iron at 35s. 6d. per ton, delivered works.

Metals.

Copper.—Consumers are evincing little desire to buy forward, and the consumptive demand remains generally limited. The Government has yet to decide upon the date upon which the agreed duty on non-Empire copper is to come into force, and the announcement is being anxiously awaited in trade circles. The impending meeting of producers in America is also attracting considerable interest, it being rumoured that further important measures with regard to output restriction are contemplated.

Closing quotations :—

Cash.—Thursday, £30 5s. to £30 6s. 3d.; Friday, £30 5s. to £30 6s. 3d.; Monday, £31 12s. 6d. to £31 15s.; Tuesday, £33 2s. 6d. to £33 5s.; Wednesday, £32 17s. 6d. to £33.

Three Months. — Thursday, £30 7s. 6d. to £30 8s. 9d.; Friday, £30 8s. 9d. to £30 10s.; Monday, £31 16s. 3d. to £31 18s. 9d.; Tuesday, £33 6s. 3d. to £33 8s. 9d.; Wednesday, £33 2s. 6d. to £33 3s. 9d.

Tin.—The demand from consumers is somewhat spasmodic, improved business being done with the Welsh tinplate mills and with some parts of the Continent. At present the chief factor in maintaining values seems to be the ready support given by the various "pools" whenever the market shows signs of weakness. Little interest is being shown by United States consumers.

Official closing prices :—

Cash.—Thursday, £152 5s. to £152 7s. 6d.; Friday, £152 2s. 6d. to £152 5s.; Monday, £153 5s. to £153 7s. 6d.; Tuesday, £155 5s. to £155 10s.; Wednesday, £155 12s. 6d. to £155 15s.

Three Months.—Thursday, £153 to £153 5s.; Friday, £152 17s. 6d. to £153; Monday, £153 17s. 6d. to £154; Tuesday, £156 to £156 5s.; Wednesday, £156 to £156 5s.

Spelter.—Consumers continue to make a fair call for supplies, and this, coupled with the strict rationing of output, accounts for the steadiness of the market during the recent period of exchange fluctuations. The outlook points to a rise in price levels, in view of the probability of an early increase in consumptive activity.

Daily fluctuations :—

Ordinary. — Thursday, £15 1s. 3d.; Friday, £15 2s. 6d.; Monday, £15 5s.; Tuesday, £15 10s.; Wednesday, £15 8s. 9d.

Lead.—Business remains fair, consumers being content to cover their immediate requirements. Heavy stocks continue to be held in many quarters, and it will require a considerable increase in activity in the consuming industries to effect an improvement in the situation.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £11 15s.; Friday, £11 17s. 6d.; Monday, £12 2s. 6d.; Tuesday, £12 8s. 9d.; Wednesday, £12 11s. 3d.

Manufacture of Cast Iron in the Rotary Pulverised Fuel Furnace.

(*Concluded from page* 288.)

lining, but he had experiments in hand which he thought would improve that. Mr. Campbell inquired about the cost of a furnace, he would give him that after the meeting. With regard to the holding of the metal for long periods when making large castings, he was making experiments to overcome that difficulty. He thought, however, that 40- or 50-ton castings were only occasional problems. In regard to the lining, Mr. Campbell had probably spent a great deal more on his patching than the lining of a Brackelsberg would have cost. He did not recommend trying to reduce sulphur or phosphorus in the furnace or on any account the use of a basic lining. The fuel was carried through the burner in a current of air when it met the heated secondary air. In regard to continuous melting, he thought that was only an occasional requirement, but if necessary an arrangement of furnaces could be made so as to secure a continuous supply of metal.

A hearty vote of thanks to the lecturer was then accorded, and the meeting was closed.

Cause and Effect in Bronze Founding.

(*Concluded from page* 283.)

Education of the User.

In conclusion, the author would reiterate that every care and much precaution is needed, if bronze castings of the highest physical properties are to be made. Many bronze foundries may retort that a really high-grade bronze casting is not appreciated by many users and purchasers, and the founder in the majority of cases is not recompensed for the extra cost and trouble. Whilst this is partially true, the remedy lies largely in the bronze founder's hands to educate the bronze user in the superiority of the carefully-made casting. It is only by such means that the general standard can be raised and enable bronze castings to successfully contend with the increased efficiency now demanded from them.

New Companies.

Metal Processes, Limited, Sardinia House, Kingsway, London, W.C.—Capital, £3,000. Directors: A. Slatter and W. J. Turner.

H. J. Gifford, Limited.—Capital £2,000. Engineers. Directors: H. J. Gifford, 181, Winchester Road, Basingstoke; K. F. Jordan.

Willson Lathes, Limited, Alexander Works, Hare Street, Halifax.—Capital £5,000. Directors: A. Kitchen, G. Willson and J. Richardson.

Parr Welding Company, Limited, 69, North Western Street, Ardwick, Manchester.—Capital, £500. Directors: S., A. E., R., and F. Parr.

H. E. Lupton & Sons, Limited, Scaitcliffe Works, Ranger Street, Accrington.—Capital £10,000. Iron and brass founders. Directors: H. and H. E. Lupton.

Taylor & Atkinson, Limited, 16, Graham Square, Edinburgh.—Capital £10,000. Ironmasters. Directors: G. Taylor, W. Atkinson, J. G. and G. R. Watson.

Barton Williams & Company, Limited, 17 & 19a, Leopold Street, Birmingham.—Capital £7,500. Metal refiners. Directors: J. B. Williams and J. Needham.

Hoffmann Steel Construction Company, Limited.—Capital £100. Directors: P. Hoffmann and L. Holzer. Secretary: R. B. Donovan, Hansahaus, Cologne, Germany.

XUM

REPEAT STERLING ORDERS ARE POSITIVE PROOF OF SATISFACTION

Month after month more and more foundries adopt Sterling Boxes as their standard.

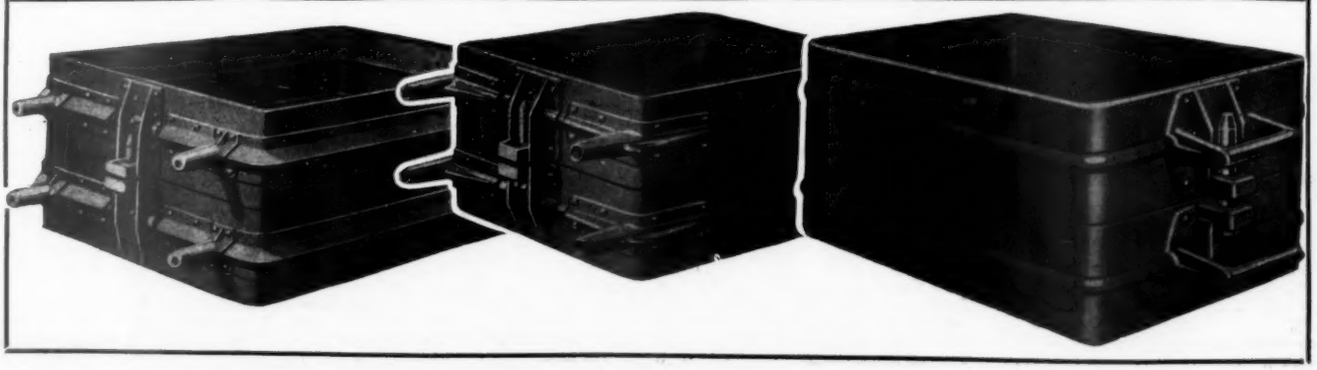
Month after month the abundance of repeat orders received proves conclusively that the Sterling Box is correct in design, competitive in price and satisfactory in service.

STERLING
FOUNDRY SPECIALTIES LTD.,
BEDFORD.

London Office: 13, VICTORIA STREET, S.W.1.

Let us make your Moulding Boxes for you. We are the leading specialists in this line. We supply Boxes for all foundry services and will design them to suit your special conditions if necessary.

YOUR TRIAL ORDER WILL MEAN YOUR REPEAT ORDER



WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	32 17 6
Three months	33 2 6
Electrolytic	37 10 0
Tough	35 0 0
Best selected	35 10 0
Sheets	65 0 0
India	45 0 0
Wire bars	37 0 0
Do., Dec.	37 2 6
Do., Jan.	37 5 0
Ingot bars	37 0 0
H.C. wire rods	39 10 0
Off. av. cash, October	31 18 7 3/4
Do., 3 mths., October	32 1 8 1/2
Do., Sttlmnt., October	31 18 8 1/2
Do., Electro, October	36 10 11 1/2
Do., B.S., October	34 15 0
Do., wire bars, October	36 18 1 1/2
Solid drawn tubes	10d.
Brazed tubes	10 1/4d.
Wire	7d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7 3/4d.
Wire	7 1/4d.
Rolled metal	7 1/2d.
Yellow metal rods	4 1/2d.
Do. 4 × 4 Squares	5 1/2d.
Do. 4 × 3 Sheets	5 1/2d.

TIN.

	£ s. d.
Standard cash	155 12 6
Three months	156 0 0
English	156 5 0
Bars	159 0 0
Straits	161 0 0
Australian	159 5 0
Eastern	160 0 0
Banca	162 5 0
Off. av. cash, October	151 7 6
Do., 3 mths., October	152 4 10 1/2
Do., Sttlmt., October	151 7 7 1/2

SPELTER.

	£ s. d.
Ordinary	15 8 9
Remelted	15 0 0
Hard	13 0 0
Electro 99.9	17 10 0
English	16 10 0
India	14 5 0
Zinc dust	22 0 0
Zinc ashes	2 5 0
Off. aver., October	15 0 1 1/4
Aver. spot, October	14 17 4 1/2

LEAD.

	£ s. d.
Soft foreign ppt.	12 11 3
Empire	13 0 0
English	14 0 0
Off. average, October	12 1 3 1/4
Average spot, October	11 19 2

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	24 10 0
Do., V.M. ex-whse.	23 0 0
Rods	27 0 0
Boiler plates	23 0 0
Battery plates	—

ANTIMONY.

	£ s. d.
English	35 0 0 to 42 10 0
Chinese	26 15 0
Crude	18 10 0

QUICKSILVER.

	£ s. d.
Quicksilver	10 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£8 0 0
45/50%	£13 15 0
75%	£19 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£20 0 0
Ferro-tungsten—	
80/85%	1/7 1/2 lb.
Tungsten metal powder—	
98/99%	1/10 1/2 lb.
Ferro-chrome—	
2/4% car.	£32 17 6
4/6% car.	£23 2 6
6/8% car.	£24 7 6
8/10% car.	£23 10 0
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£40 2 6
Max. 0.70% car.	£43 17 6
70%, carbon-free	1/- lb.
Nickel—80/99.5%	£250 to £255
"F" nickel shot	£225 0 0
Ferro-cobalt	7/9 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/9 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under 1/4 in. to 1/4 in.	3d. lb.
Do., under 1/4 in. to 1/16 in.	1/- lb.
Flats, 1/4 in. × 1/4 in. to under 1 in. × 3/8 in.	3d. lb.
Do., under 1/4 in. × 1/4 in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	1 17 6	
Bundled steel and shrngs.	1 15 0	to 1 17 0
Mixed iron and steel	1 10 0	to 1 14 0
Heavy cast iron	1 18 0	to 2 0 0
Good machinery	2 5 0	
Cleveland—		
Heavy steel	1 15 0	
Steel turnings	1 7 6	
Cast-iron borings	1 2 6	
Heavy forge	2 10 0	
W.I. piling scrap	2 2 6	
Cast-iron scrap	1 15 0	to 1 16 0
Midlands—		
Light cast-iron scrap	1 15 6	
Heavy wrought iron	2 5 0	
Steel turnings, f.o.r.	0 19 6	
Scotland—		
Heavy steel	1 12 6	to 1 15 0
Ordinary cast iron	1 19 0	
Engineers' turnings	1 8 0	
Cast-iron borings	1 10 0	
Wrought-iron piling	1 18 6	
Heavy machinery	2 4 0	

London—Merchants' buying prices delivered yard.

	£ s. d.
Copper (clean)	25 0 0
Brass	16 0 0
Lead (less usual draft)	10 10 0
Tea lead	9 0 0
Zinc	8 10 0
New aluminium cuttings	72 0 0
Braziery copper	22 0 0
Gunmetal	21 0 0
Hollow pewter	82 0 0
Shaped black pewter	65 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	59/6
Hematite M/Nos.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	69/-
„ d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs No. 4 forge*	61/-
„ No. 3 fdry.*	66/-
Shrops basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	57/6
„ fdry. No. 3*	62/6
„ fdry. No. 1*	65/6
Derbyshire forge*	61/-
„ fdry. No. 3*	66/-
„ fdry. No. 1*	69/-
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	70/-
„ No. 3	67/6
Hem. M/Nos. d/d	67/6
Sheffield (d/d district)—	
Derby forge	58/6
„ fdry. No. 3	63/6
Lincs forge	—
„ fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
„ fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	83/- to 84/-
Clyde, No. 3	83/- to 84/-
Monkland, No. 3	83/- to 84/-
Summerlee, No. 3	83/- to 84/-
Eglinton, No. 3	83/- to 84/-
Gartsherrie, No. 3	83/- to 84/-
Shotts, No. 3	83/- to 84/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.)	9 0 0 to	9 15 0
Nut and bolt iron	7 15 0 to	8 7 6
Hoops	10 10 0 to	12 0 0
Marked bars (Staffs) f.o.t.		12 0 0
Gas strip	10 10 0 to	12 0 0
Bolts and nuts, 1/4 in. × 4 in.		12 5 0
Steel—		
Plates, ship, etc.	8 15 0 to	8 17 6
Boiler plts.	8 7 6 to	9 5 0
Chequer plts.		10 7 6
Angles		8 7 6
Tees		9 7 6
Joists		8 15 0
Rounds and squares, 3 in. to 5/8 in.		9 7 6
Rounds under 3 in. to 1/4 in. (Untested)	6 15 0	& up.
Flats—8 in. wide and over		8 12 6
„ under 8 in. and over 5 in.		8 17 6
Rails, heavy	8 5 0 to	8 10 0
Fishp ates		12 0 0
Hoops (Staffs)	9 10 0 to	10 10 0
Black sheets, 24g. (10-t. lots)		9 5 0
Galv. cor. shts. „		11 5 0
Galv. flat shts. „		11 15 0
Galv. fencing wire, 8g. plain		14 0 0
Billets, soft	4 17 6 to	5 7 6
Billets, hard	6 12 6 to	7 2 6
Sheet bars	4 15 0 to	5 2 6
Tin bars		4 15 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10 3/4d.
Sheet to 10 w.g.	11 3/4d.
Wire	11 1/4d.
Rods	10 3/4d.
Tubes	16 1/4d.
Castings	12 1/2d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1 1/2 to 1/7 1/2
To 15 in. wide	1/1 1/2 to 1/7 1/2
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2 1/2 to 1/8 1/2
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3 1/2
Ingots rolled to spoon size	10d. to 1/6 1/2
Wire round—	
to 10g.	1/4 1/2 to 1/11 1/2

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3 1/2 upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.59
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	37.00
	Cents.
Iron bars, Phila.	2.11
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.10
Sheets, galv., No. 24	2.85
Wire nails	1.95
Plain wire	2.20
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	20/- to 22/6
„ furnace	16/- to 16/6
Durham and Northumberland—	
„ foundry	21/- to 25/-
„ furnace	12/- to 12/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	15/9 to 16/3
„	28×20 „	31/6 to 32/6
„	20×10 „	22/7 1/2 to 23/-
„	18 1/4×14 „	16/4 1/2 to 16/7 1/2
C.W.	20×14 „	13/6 to 14/-
„	28×20 „	—
„	20×10 „	—
„	18 1/4×14 „	—

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 10 0 to £17 0 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 5 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
Nov.	3 ..	30	5	0	inc. 6/3
,,	4 ..	30	5	0	No change
,,	7 ..	31	12	6	inc. 27/6
,,	8 ..	33	2	6	,, 30/–
,,	9 ..	32	17	6	dec. 5/–

Electrolytic Copper.

		£	s.	d.	
Nov.	3 ..	34	15	0	No change
,,	4 ..	34	15	0	,, ,,
,,	7 ..	35	10	0	inc. 15/–
,,	8 ..	36	15	0	,, 25/–
,,	9 ..	37	10	0	,, 15/–

Standard Tin (cash).

		£	s.	d.	
Nov.	3 ..	152	5	0	inc. 2/6
,,	4 ..	152	2	6	dec. 2/6
,,	7 ..	153	5	0	inc. 22/6
,,	8 ..	155	5	0	,, 40/–
,,	9 ..	155	12	6	,, 7/6

Tin (English ingots).

		£	s.	d.	
Nov.	3 ..	152	15	0	No change
,,	4 ..	152	15	0	,, ,,
,,	7 ..	153	15	0	inc. 20/–
,,	8 ..	155	15	0	,, 40/–
,,	9 ..	156	5	0	,, 10/–

Spelter (ordinary).

		£	s.	d.	
Nov.	3 ..	15	1	3	dec. 1/3
,,	4 ..	15	2	6	inc. 1/3
,,	7 ..	15	5	0	,, 2/6
,,	8 ..	15	10	0	,, 5/–
,,	9 ..	15	8	9	dec. 1/3

Spelter (Electro, 99.9 per cent.).

		£	s.	d.	
Nov.	3 ..	17	5	0	dec. 2/6
,,	4 ..	17	5	0	No change
,,	7 ..	17	5	0	,, ,,
,,	8 ..	17	10	0	inc. 5/–
,,	9 ..	17	10	0	No change

Zinc Sheets (English).

		£	s.	d.	
Nov.	3 ..	24	10	0	No change
,,	4 ..	24	10	0	,, ,,
,,	7 ..	24	10	0	,, ,,
,,	8 ..	24	10	0	,, ,,
,,	9 ..	24	10	0	,, ,,

Lead (English).

		£	s.	d.	
Nov.	3 ..	13	10	0	No change
,,	4 ..	13	10	0	,, ,,
,,	7 ..	13	10	0	,, ,,
,,	8 ..	14	0	0	inc. 10/–
,,	9 ..	14	0	0	No change

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1895	5 15 0	5 15 0	5 12 6	5 12 6	5 15 0	5 17 6	5 15 0	5 17 6	6 0 0	6 0 0	6 2 6	6 0 0	5 16 10½
1896	6 0 0	6 0 0	6 2 6	6 2 6	6 2 6	6 0 0	6 0 0	6 0 0	6 0 0	6 2 6	6 10 0	6 10 0	6 2 6
1897	6 10 0	6 10 0	6 10 0	6 7 6	6 2 6	6 2 6	6 5 0	6 0 0	6 0 0	6 0 0	6 7 6	6 10 0	6 5 5
1898	6 10 0	6 8 9	6 8 9	6 10 0	6 15 0	6 18 9	6 17 6	6 17 6	7 2 6	6 15 0	7 0 0	7 5 0	6 15 8½
1899	7 5 0	8 0 0	8 2 6	8 2 6	8 5 0	8 5 0	8 12 6	8 12 6	8 15 0	8 15 0	9 2 6	9 5 0	8 17 8½
1900	9 5 0	9 5 0	9 7 6	9 10 0	9 12 6	10 5 0	10 5 0	10 5 0	10 5 0	10 0 0	9 15 0	9 15 0	9 15 10
1901	9 5 0	9 5 0	8 15 0	8 10 0	8 10 0	7 10 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	7 15 0	8 3 11
1902	7 7 6	7 0 0	7 12 6	7 12 6	7 12 6	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 9 7
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 8
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	19 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	11 10 0	12 11 5½
1926	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	10 10 0	10 19 0½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 5 0	10 1 3	10 1 3	10 1 3	10 1 7	10 6 8½
1930	10 2 9	10 3 5½	10 3 9	10 3 6	10 2 6	10 2 6	10 2 6	10 2 2½	9 19 6	9 16 3	9 16 3	10 1 6½	
1931	9 15 0	9 15 0	9 15 0	9 10 11	9 6 9	9 5 0	9 7 0	9 7 9½	9 8 9	9 5 9	9 5 6	9 9 6	9 9 4
1932	9 5 0	9 2 6	8 18 6	8 17 6	8 16 6½	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	—	—	—

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